Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BLDG. MARCH, 1942 PITTSBURGH, PA.

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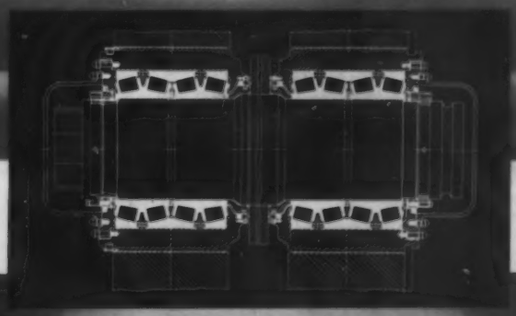
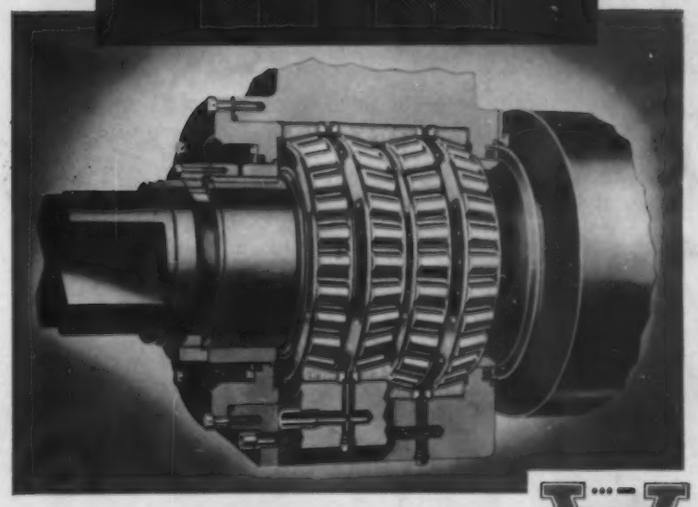
DETROIT
TECHNOLOGY DEPT.

Timken Bearings Are Keeping 'Em Rolling For Victory. After Victory they'll Keep 'Em Rolling For Prosperity.

Timken 4-Row Roll Neck Bearings as applied to the roll necks of a modern continuous strip mill.





In this strenuous period of emergency the superior speed, accuracy, dependability and endurance of Timken Roll Neck Bearings is a source of great gratification and relief to rolling mill operators.

At no previous time have these bearings been put to such a severe test nor more completely justified the preference of their users.

In strip mills, sheet mills, plate mills and bar mills they keep the steel coming through without unscheduled interruptions for bearing changes.

Furthermore, Timken Roll Neck Bearings are credited with the lowest bearing cost per ton rolled ever recorded in the steel industry. This advantage will be of particular value if and when severe competitive conditions return.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

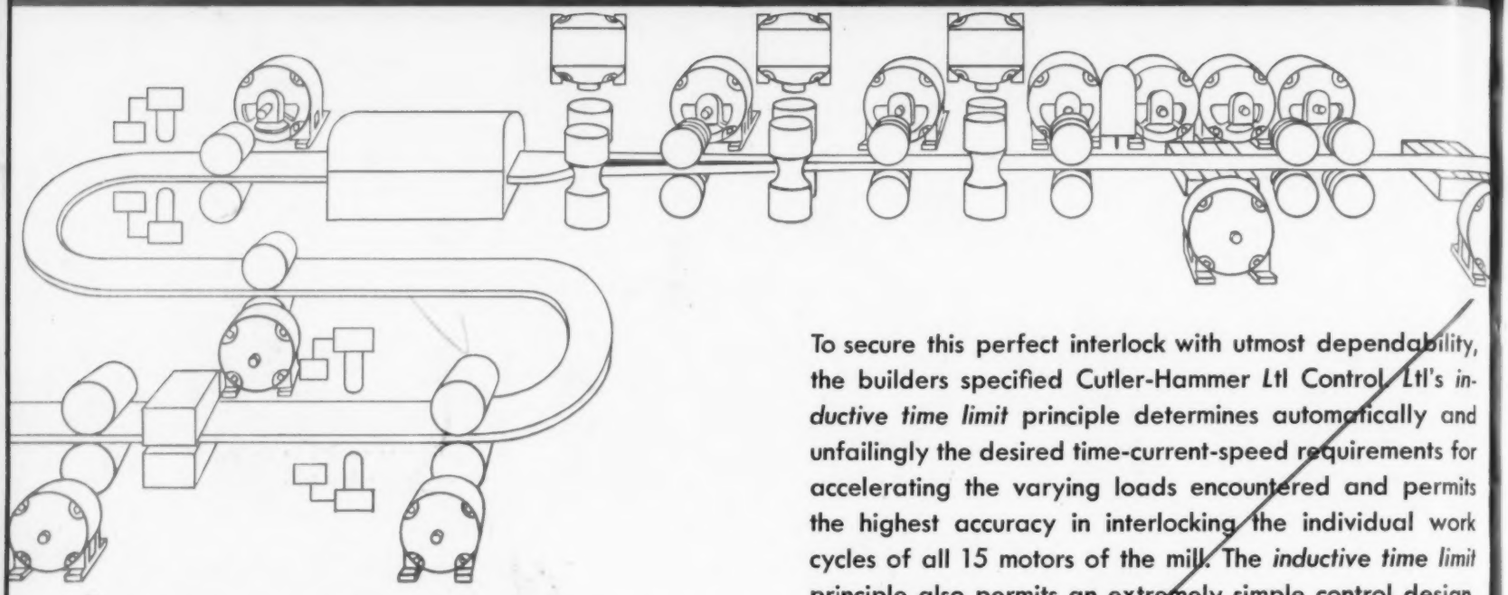
V
TO ASSURE VICTORY
BUY UNITED STATES DEFENSE BONDS & STAMPS

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

C-H Ltl Control

Makes 15 Motors Work as One

in this Continuous Buttweld Pipe Mill



THE continuous weld pipe mill diagrammed above, installed in a large midwestern steel mill, represents a tough control problem. Coils of skelp are uncoiled, cropped square, welded end-to-end, heated, rolled into pipe, butt welded, sized, sawed, descaled, straightened, and stacked . . . all in an automatic continuous process. And during this continuous process some motors must be stopped, slowed down, accelerated, or run at pre-set speed—all without interrupting the continuous flow at the finishing end: consequently, every one of them must be perfectly interlocked with all the others.

To secure this perfect interlock with utmost dependability, the builders specified Cutler-Hammer Ltl Control. Ltl's *inductive time limit* principle determines automatically and unfailingly the desired time-current-speed requirements for accelerating the varying loads encountered and permits the highest accuracy in interlocking the individual work cycles of all 15 motors of the mill. The *inductive time limit* principle also permits an extremely simple control design, which, along with Cutler-Hammer's rugged, steel-mill-duty construction, results in the utmost dependability and the longest "staying power" on the job.

Whatever your steel mill requirements, you will find Cutler-Hammer Control engineered exactly to the job . . . whether for rolling mills, cranes, hot-beds, conveyors, etc. Take advantage of Cutler-Hammer's 50 years of experience in solving the toughest steel mill motor control problems CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

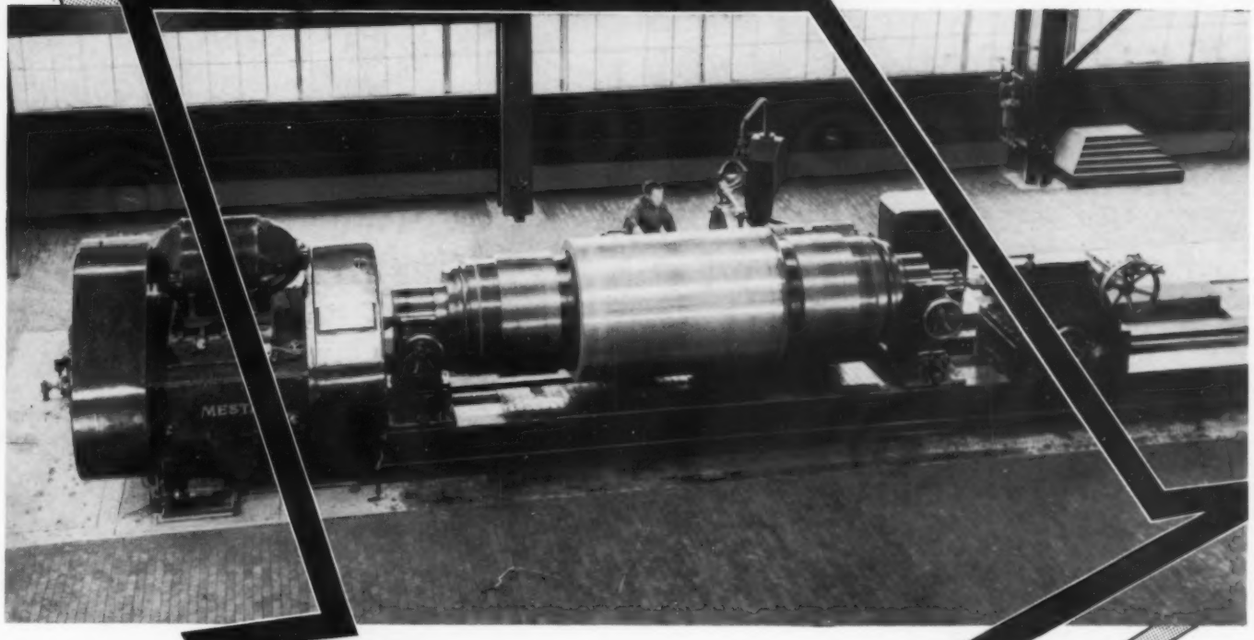
Installation of Control Desk for Ltl Magnetic Controllers. Operator in full view of forming, welding, and hot saw operations.

1892-1942 50th ANNIVERSARY

CUTLER-HAMMER
MOTOR CONTROL
C-H

TECHNOLOGY DEPT.

MESTA



MESTA was among the first to be awarded the FLAG of the UNITED STATES BUREAU OF ORDNANCE and NAVY "E" PENNANT.

HEAT TREATED SPECIAL ALLOY STEEL BACKING-UP

ROLLS

For Four High HOT AND COLD MILLS

MESTA MACHINE COMPANY, PITTSBURGH, PA. U. S. A.

Pennsylvania

introduces a new

STRAIGHT-LINE TAP CHANGER

for Power Transformers

with

silver-to-silver contacts

RETAINING the fundamental and highly desirable principle of straight-line movement, Pennsylvania introduces valuable improvements in its tap changer for Power Transformers. This new tap changer with its silver-to-silver contacts is capable of carrying heavy overloads without overheating, and is able to withstand "dead" short circuits without detrimental effects. Tests have been made to fully prove these characteristics.

This development is evidence of Pennsylvania's continuous research to provide the utmost in transformer life and reliability — a research increasingly important to Industry's Victory Program.

How it operates

The insulating shaft **(1)** carries on its end a steel gear, which is hidden from view. This gear engages a cadmium plated steel rack **(2)**. The rack carries two self-adjusting and self-aligning steel springs **(3)**. On the end of each spring is mounted a copper jaw with silver inlays **(4)**. The pressure of the spring is transmitted to the movable jaws which make contact by bearing against silver rivets **(5)** imbedded in stationary copper jaws **(6)**. The transformer leads are bolted on to the stationary jaws.

The supporting frame **(7)** is fabricated of insulating material of great mechanical and electrical strength. Electrostatic Shields **(8)** are provided on high voltage tap changers to eliminate corona.

The movable jaw, actuated by the rack and gear, travels in a straight line. No lost motion, no-misalignment!

Life-Tested!

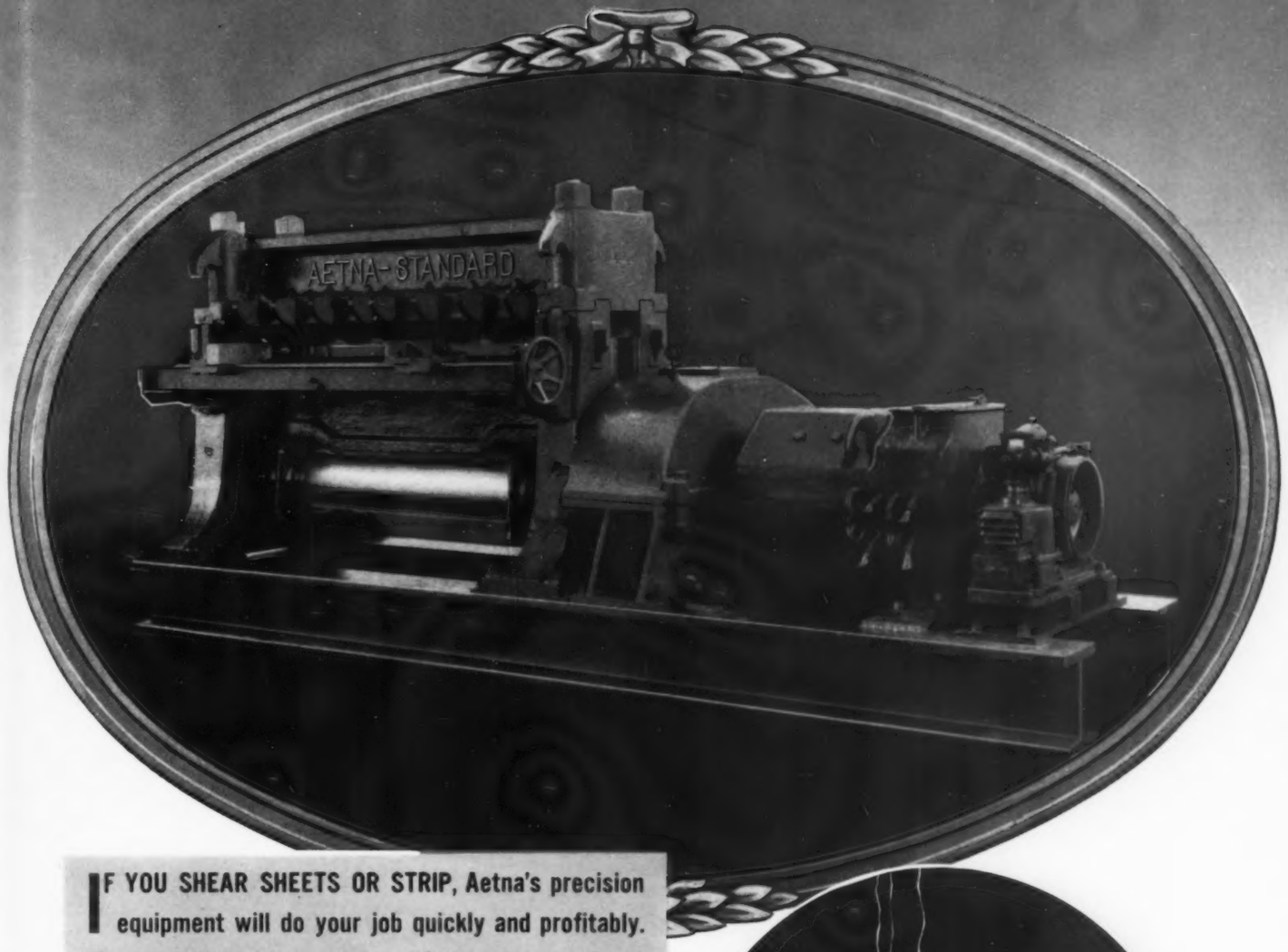
Tap-changer subjected to 100,000 full operations— considerably more than would occur during normal life of a Transformer!

Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, • N. S., PITTSBURGH, PA.

In America's Production for Victory . .

Where Does Aetna Fit Your Picture?



IF YOU SHEAR SHEETS OR STRIP, Aetna's precision equipment will do your job quickly and profitably. The shear illustrated performs fifteen cuts per minute on sheet or strip steel up to seven gauge, seventy-four inches wide. This shear, however, is built for various gauges and widths.

The AETNA-STANDARD ENGINEERING COMPANY

• YOUNGSTOWN, OHIO, U.S.A. •

WARREN, OHIO, PLANT.

ELLWOOD CITY, PENN. PLANT.

ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND • AKTIEBOLAGET ARBOGA MEKANISKA VERKSTAD, ARBOGA, SWEDEN • JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Designers and Builders to the Steel, Non-ferrous and Chemical Industries

Cushioning Impact Loads on Roll Neck Bearings

THE "CORRECT" ANSWER TO ANOTHER TOUGH PROBLEM IN VITAL STEEL PRODUCTION:

Problem: This giant roller bearing helps roll out steel. Despite its size, it is made with watch-like accuracy and mirror-like finish. This type bearing is made for a definite period of useful life. But severe operating conditions —involving high pressures—will shorten that life unless a special grease is used to protect polished rollers and races.

Answer: *Gargoyle L Greases* have the extremely high load-carrying ability to protect the bearings from damage under high pressures. These special greases are also designed to stand up under constant churning and protect the mirror-like surfaces of rollers and races from pitting and consequent failure. They help assure dependable operation for the full span of the bearing's intended life.

For circulation-oiled roll neck bearings, *Gargoyle Vacuoline Oils* give equally efficient service.

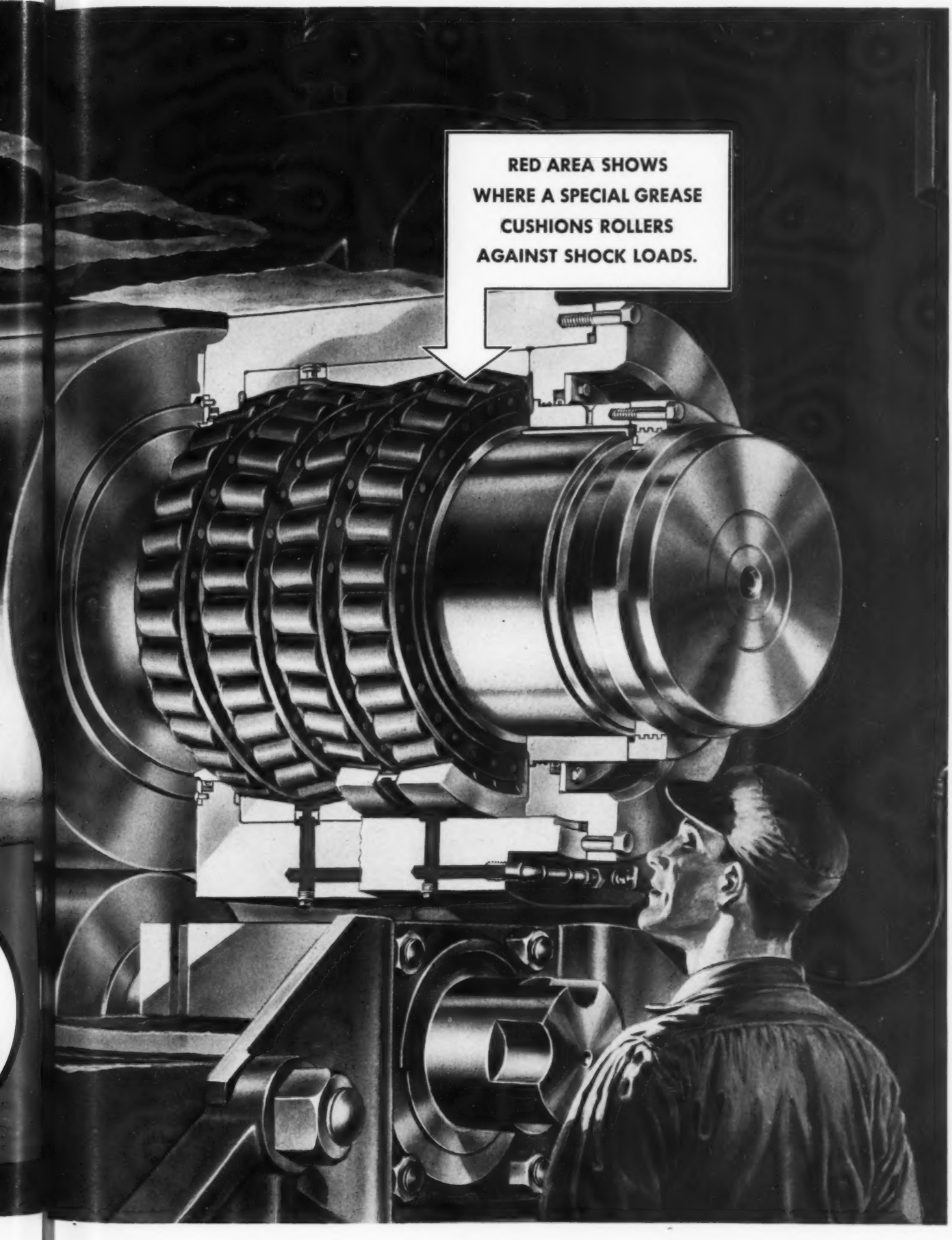
TO HELP MAINTAIN CAPACITY PRODUCTION, CALL IN

SOCONY-VACUUM for "Correct Lubrication"

SOCONY-VACUUM OIL CO., INC. — Standard Oil of N. Y. Div. — White Star Div. Lubrite Div. — Chicago Div. — White Eagle Div. — Wadhams Div. — Southeastern Div. (Baltimore) — Magnolia Petroleum Company — General Petroleum Corporation of Calif.

GARGOYLE

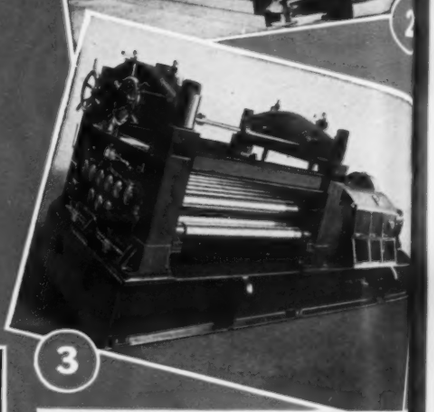
Lubricants

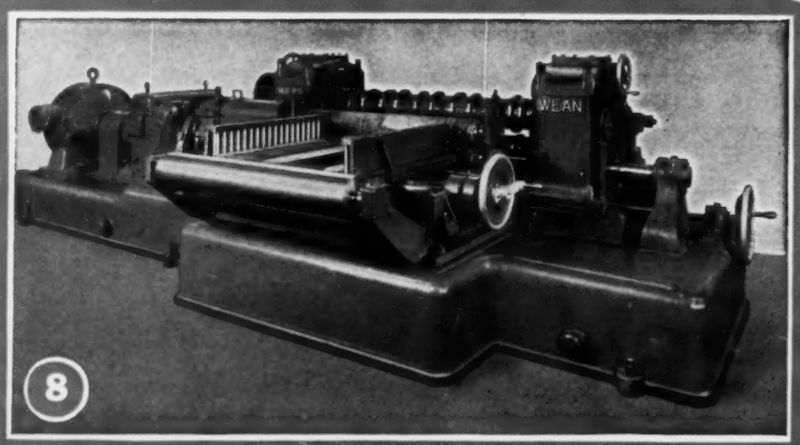

RED AREA SHOWS
WHERE A SPECIAL GREASE
CUSHIONS ROLLERS
AGAINST SHOCK LOADS.

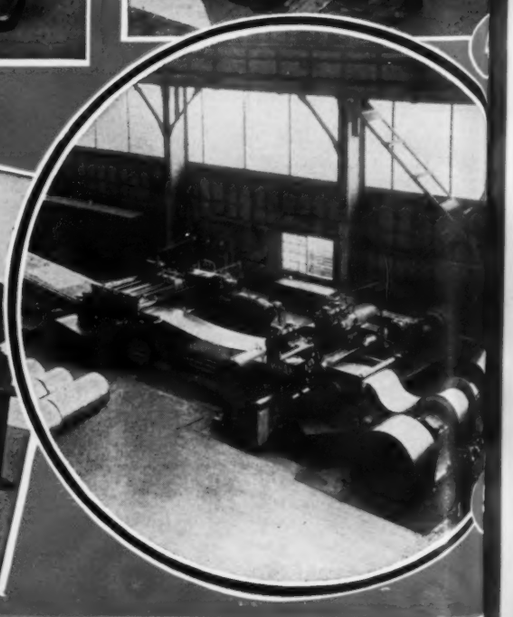
WEAN

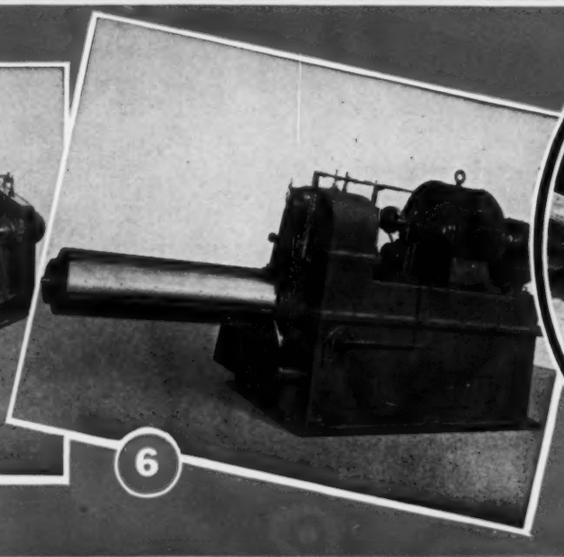
WEAN EQUIPMENT for opening "PRODUCTION BOTTLENECKS"

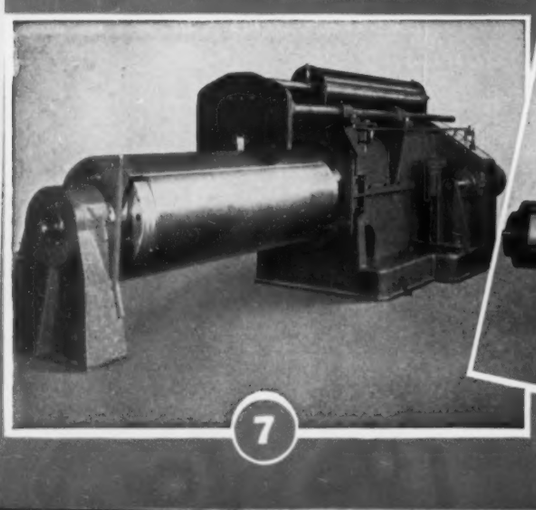
1. Wean Tin Plate Shearing Line
2. Wilson Annealing Furnace
3. Heavy Duty Leveller
4. Hydraulic Stretcher Leveller
5. Wean Strip Shearing Line
6. Wean Reel (Expanding Type)
7. Wean Reel (Tension Type)
8. Slitter or Side Trimmer (Combination Type)











ASSOCIATED COMPANIES

LEE WILSON ENGINEERING COMPANY
Cleveland, Ohio

THE McKAY MACHINE COMPANY
Youngstown, Ohio

FLINN & DREFFEIN CO.
Chicago, Ill.

THE WELLMAN SMITH OWENS ENGINEERING CORP., Ltd.
London, England

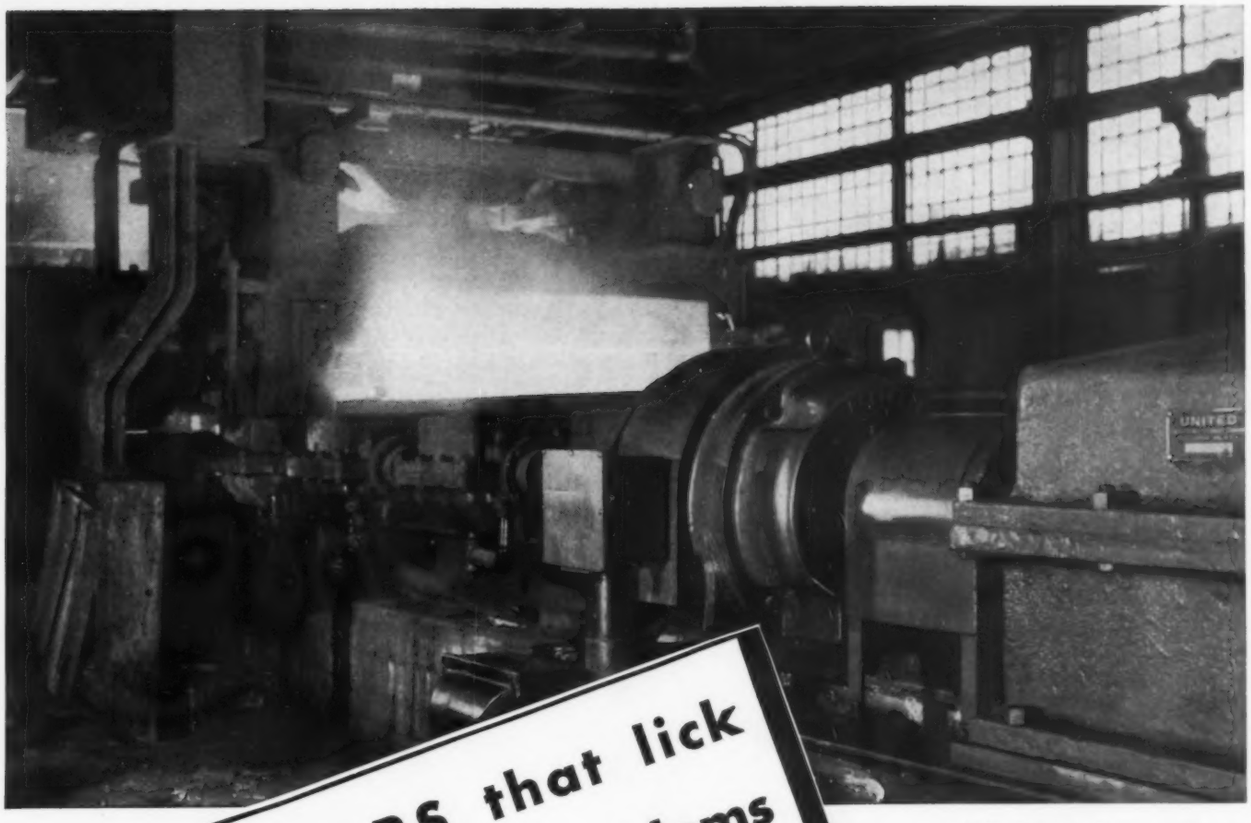
THE HALLDEN MACHINE CO.
Thomaston, Conn.

THE WEAN ENGINEERING CO. of Canada, Ltd.
Hamilton, Ontario

Subsidiary Company
THE BRODEN CONSTRUCTION CO.
Cleveland, Ohio
Manufacturers of
Strip and Wire Mill Machinery

The WEAN ENGINEERING Company, Inc.

WARREN, OHIO



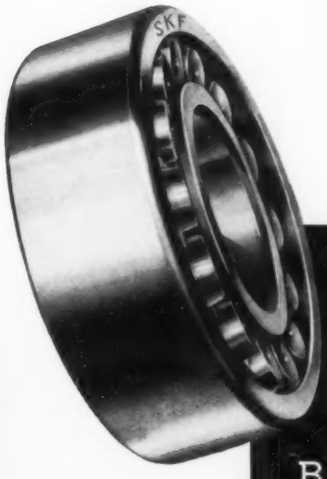
● *Built by the Reliance Electric and Engineering Co.*

On MOTORS that lick ...PRODUCTION Problems

In the roll call for Performance in today's war effort, the Steel Industry answers "Here!" with SKF-equipped motors that work smoothly the clock around the year around. That's particularly true of this 50 h.p., 855 r.p.m., Form PSH, Type AA Motor that, exposed to steam and dust, hums merrily along on the geared table between stands of a hot blooming mill year after year on SKF Spherical Roller Bearings. Rugged, practically frictionless, and with unvarying precision that assures a permanently maintained air gap, SKF's easily carry heavy radial and thrust loads . . . assure maximum efficiency in the transfer of power. Where Performance is the thing that counts, the bearings are SKF.

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA.

4996



SKF

BALL AND ROLLER BEARINGS

Exide knows the value of time

Time is irreplaceable. Time lost can never be found again . . . nor can it be bought or borrowed. In the urgency of a great national effort, this truth is rammed forcefully home.

Maintenance men who have in the past insisted on Exide-Ironclad Batteries know well the value of Time. Ease of maintenance and unceasing dependability make Exide-Ironclads, in electric industrial trucks, front-rank fighters in the war against wasted minutes, hours, and days. Exide helps *Keep America Rolling!*

Exide
IRONCLAD
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

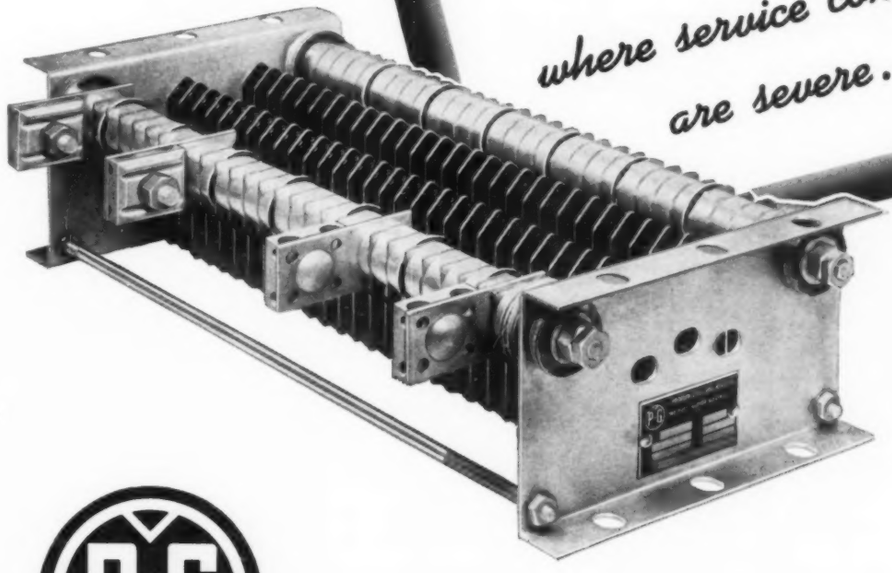
Steel Grid Resistors

Protect Vital Electrical Equipment!

In heavy industry generally and especially in...

STEEL MILLS

where service conditions are severe...



Write for Bulletin No. 500

"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO

GET IT ROLLING...

KEEP IT ROLLING

with Westinghouse factory-assembled, ready-to-use control

Quickest and simplest way to get steel mill auxiliaries into action . . . and to KEEP them going . . . is with ready-to-use, factory-assembled and tested Westinghouse control. This "packaged control" is tailored to measure from standard units, and engineered for the job . . . whether the job involves control for *all* the auxiliaries in a new mill, or additions or changes in existing equipment.

Self-supporting structure eliminates need for field erection—sectional design makes it easy to add additional units. Control is shipped as a unit. You simply make incoming and outgoing connections, and the production equipment involved is ready to go into action. Write for booklet B-2265 for details and helpful application data. WESTINGHOUSE ELECTRIC & MFG. COMPANY, EAST PITTSBURGH, PA., Dept. 7-N.

Westinghouse Type SM Contactors
STAY ON THE JOB

Westinghouse SM Contactors reduce number of "time-outs" because the rapid motion and quick extinction of the arc minimize burning. Contact tips are extra heavy, extra durable, easily replaceable. Bearing pins and bushings are of long-life nitrided alloy steel. Vacuum and pressure impregnated coil protected against moisture, dirt, metallic dust.

J-21154

Westinghouse
STEEL MILL CONTROL

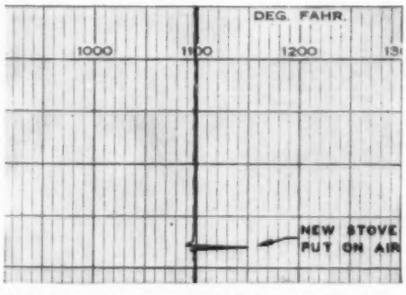
Furnace man in a Chicago mill spends much of his time at Micromax panel, where temperatures of hot-blast, stove tops, and blast furnace inwall points are all visible at a glance on these Micromax Strip-Chart, Round-Chart and Indicating Pyrometers.

Pyrometers Micro-Responsive To Steel Mill Needs

The ever-growing web of temperature-measuring circuits, spun by production engineers and metallurgists in steel mills, has been greatly simplified in many a mill by what amounts to "standardizing" on Micromax and other L&N pyrometers. Shown here are typical views, taken in such plants and presenting some of the instruments in low-maintenance, high-efficiency temperature-measuring networks.

Most users of these pyrometers say that the sensitivity and accuracy of the instruments has much to do with their success. But fully as much credit is given to the concentrated, specialized instrument engineering which has tailor-fitted these pyrometers to the individual needs of the processes found only within the steel industry.

For example, Micromax Hot-Blast Control: Here a Micromax Strip-chart Recording Controller of appropriate temperature range measures the temperature of the hot-blast at the bustle pipe, and regulates it by moving the cold-air mixer valve. Special consideration was necessary to select the correct type of couple and protecting tube; the drive-unit for the valve; the heavy-duty relays, and a mounting panel for all except the couple and drive unit. Painstaking engineering of all factors produces a system of control which makes the valve-motion micro-responsive to the couple temperature.



Final proof of "micro-responsive" control is Micromax record of automatically-controlled hot-blast temperature.

The same net result, with entirely different means, is secured in soaking pits, open-hearths, rolling mills, etc. For particulars, outline your problem and ask for appropriate literature.

Here's PYROMETER SERVICE
For Forced-Draft Production!

The applications of Micromax Pyrometers to temperature control have been worked out in such detail as to require nineteen separate publications to describe them.

Back of these books is a staff of scores of men who have made temperature-control their life work.

Therefore, if it's pyrometer information you want, we can supply it. In detail. With clean-cut, crisp recommendations. And promptly.

The control equipment on which this service is based is the Micromax family of pyrometers. They are micro-responsive—they act in most cases long before a man could act, to regulate a temperature. They can turn heat sharply up and down, if your process requires abrupt action. Or, they can "throttle" it, gently but steadily, matching every tiny temperature change with the exactly correct change in fuel supply, so that temperature, and hence product quality as affected by temperature, are constant.

Micromax Pyrometers are made in 5 models; and for either electrically-driven or diaphragm-type valves; for either thermocouples or our Rayotube radiation detecting elements. Several hundred standard ranges are available . . . to receive further information, just outline your problem.

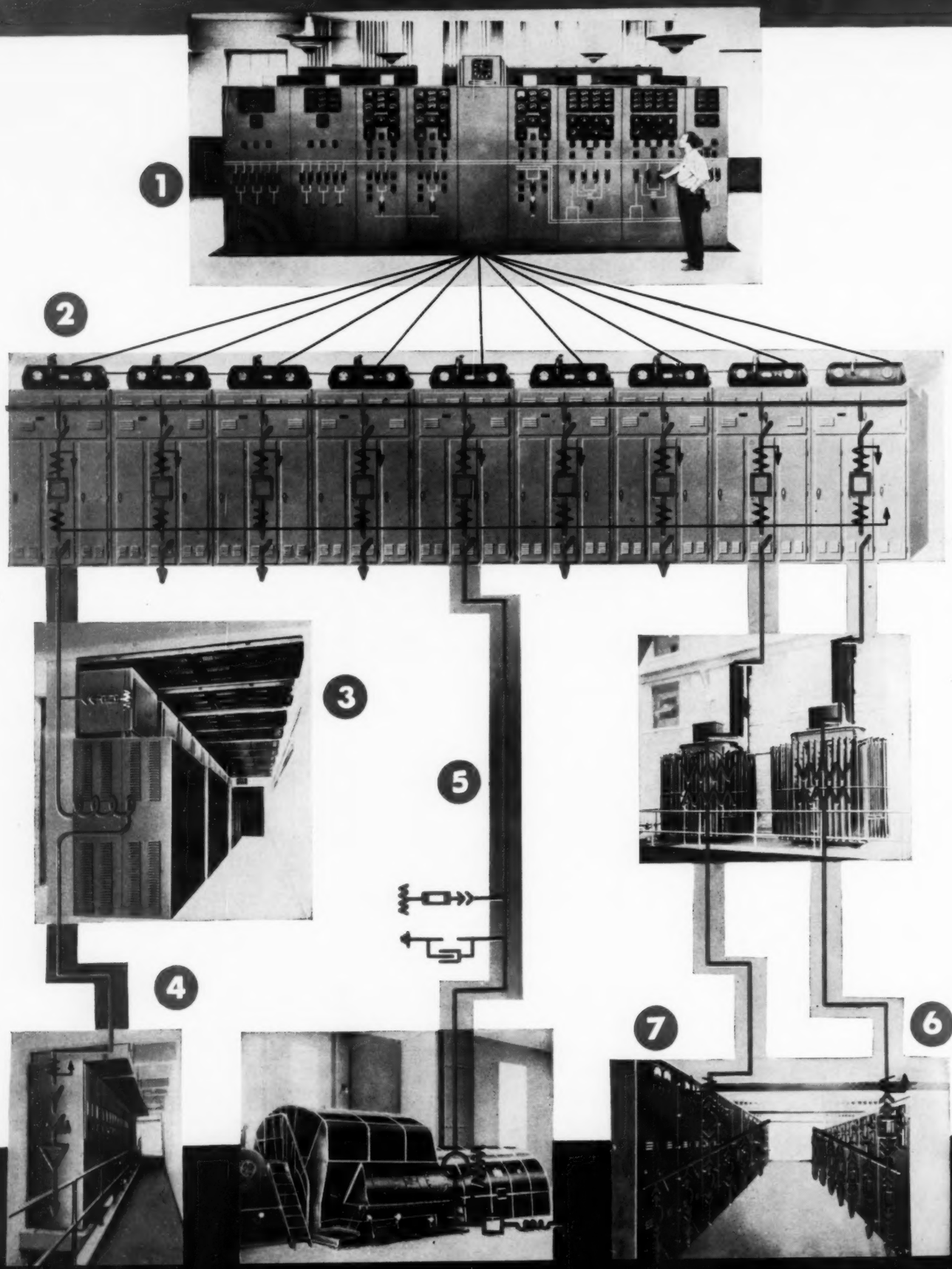
Trl Ad ENT-0600C(41)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

NOW COMPLETE METAL-ENCLOSED SW



ED SWITCHGEAR FOR YOUR ENTIRE STATION

ALL THIS--
CO-ORDINATED

1. **Metal-enclosed Duplex Switchboards** for centralized control and metering.
2. **Metal-enclosed FH Cubicles** for main power circuits, complete with air-blast or low-oil-content circuit breakers and all necessary primary equipment.
3. **Metal-enclosed Reactor Equipments** for the feeder circuits.
4. **Metal-enclosed Cable Entrance Equipments** for the feeder circuits.
5. **Metal-enclosed Bus Runs** for all primary connections.
6. **Metal-clad Switchgear** for the medium-capacity auxiliary circuits, complete with air or oil circuit breakers.
7. **Metal-enclosed Drawout Air Breaker Equipments** for the low-voltage auxiliary circuits, complete with circuit breakers, buses, interconnections, and interlocks.

SELECT IT ALL at one time
INSTALL IT ALL as a unit
THIS means—

- ★ A single transaction—one company responsible
- ★ Speedy, easy installation at a low, predictable cost
- ★ All designed as a single unit—complete co-ordination of all functions
- ★ Simplified over-all station design
- ★ The greatest safety and operating dependability assured by modern, proved equipments

THESE are *standard* switchgear equipments, but they're *tailored* for today's tremendous wartime power and production requirements.

They are the equipments for which our factory is tooled—which we have prepared to manufacture in the shortest possible time.

They are the safest and most dependable equipments we know how to build.

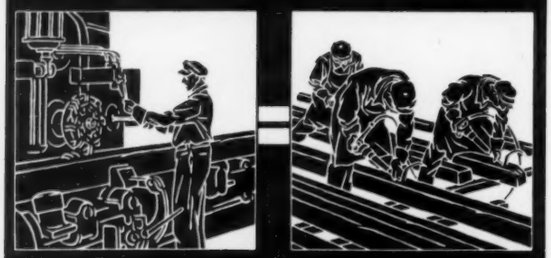
When you select *any one* of these metal-enclosed equipments, you get everything completely co-ordinated, and it's shipped ready to install. You get the savings in installation time and space that go with it.

When you select *a number of*—or all of—these equipments, you get more of the same savings in time and space, *plus* an extra degree of over-all co-ordination that may make possible a simplification of your entire station design. Ask your G-E office for Bulletin GEA-3742, or write to General Electric Company, Schenectady, New York.

General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of ordnance.

GENERAL ELECTRIC

1=10 TO 20



EACH MACHINE REQUIRES BUT ONE OPERATOR.
TEN TO TWENTY MEN WHO WOULD OTHERWISE BE REQUIRED FOR CLEANING BILLETS ARE RELEASED FOR MORE PRODUCTIVE WORK BY EVERY—

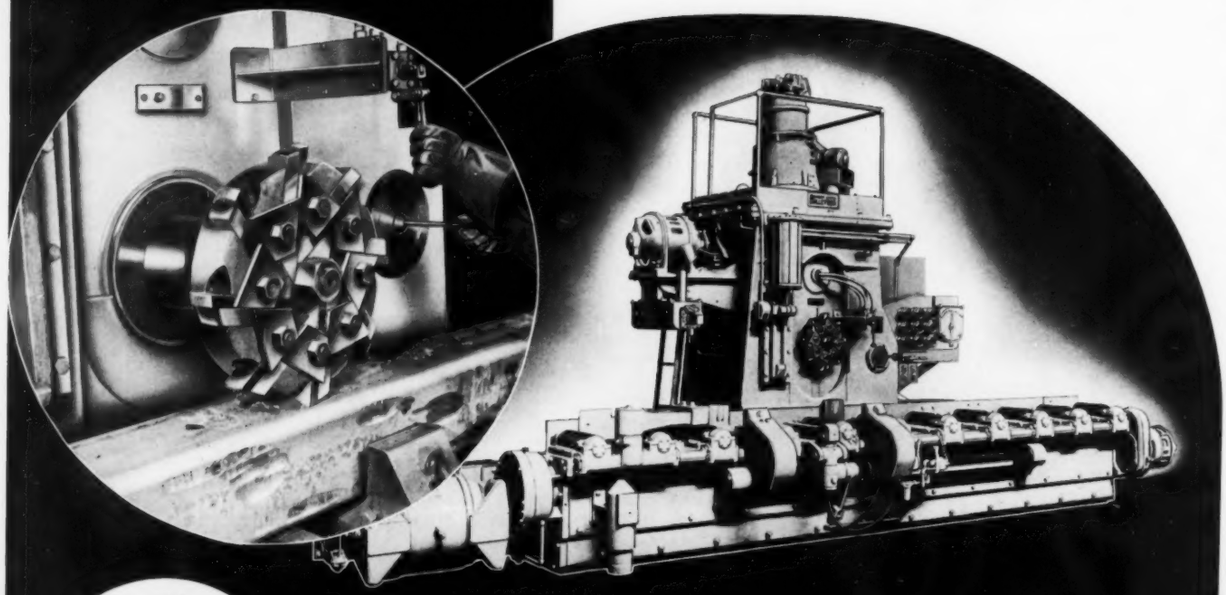
BILLETEER

SAVE JOB-HOURS TO SAVE MAN-POWER

Urgency of the need for essential equipment with which our men in arms can meet the enemy on equal footing demands maximum output from every available man-hour right down the line in production.

Man-hour output gained today will be reflected in men's lives saved tomorrow. Throughout the steel industry, many valuable man-hours are being gained by Billeteers.

If you do not already have complete data on the Billeteer, ask for it at once. Very high priority rating is given this equipment.



BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

These 2 Words

MAKE MOTOR-DRIVE *More than* POWER!

Reliance men skilled in Application Engineering start daily on new missions essential to making our great war machine produce more than we ever dreamed was possible. They are answering calls where *motor-drive must be more than power.* These are typical . . . A new tinning process to make our reduced tin supply go three times as far . . . A drive to simplify machine design and insure a top-notch production pace on a hurry-up lot of hundreds of boring mills for producing tank turrets . . . Motors to speed up production of shell-turning lathes . . . A motor-drive for an automatic towing machine that will aid sea-going tugs to handle tows with less strain and reduce chances of losing the tow . . . A hoisting motor for bringing seaplanes to a warship's deck safely in rough seas...These and many more like them are engineering jobs done in cooperation with men who *start* their design with the question, *"What can we get the motor to do besides supply power?"* Such as:

Motor-drive provides within itself a means of:

SPEED CONTROL — REVERSING
BRAKING — REMOTE CONTROL
TANDEM OPERATION — CONTROLLED ACCELERATION
TENSION CONTROL — SAFETY
SLOW SPEEDS FOR INCHING, THREADING, INSPECTION

Applying them to boost production and improve quality is APPLICATION ENGINEERING. That's our business.

Fully-enclosed, Fan-cooled D-c. Reliance Motor

Fully-enclosed, Fan-cooled A-c. Reliance Motor

RELIANCE ELECTRIC & ENGINEERING COMPANY
1088 IVANHOE ROAD • CLEVELAND, OHIO
BIRMINGHAM • BOSTON • BUFFALO • CHICAGO • CINCINNATI
DETROIT • GREENVILLE, S.C. • HOUSTON, TEX. • LOS ANGELES
MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, OREGON • ST. LOUIS • SAN FRANCISCO
SYRACUSE, N.Y. • AND OTHER PRINCIPAL CITIES

RELIANCE A-C D-C MOTORS

YALE PUMPS IMPROVE

Oil Circulation at Follansbee Steel

End Oil Breakdown Thru Agitation, Heat or Foaming . . .
Eliminate Safety Valves or Air-Balanced Pressure Tanks . . .
Avoid Pressure Build-ups . . .
Gain Economy of Installation, Operation and Maintenance . . .

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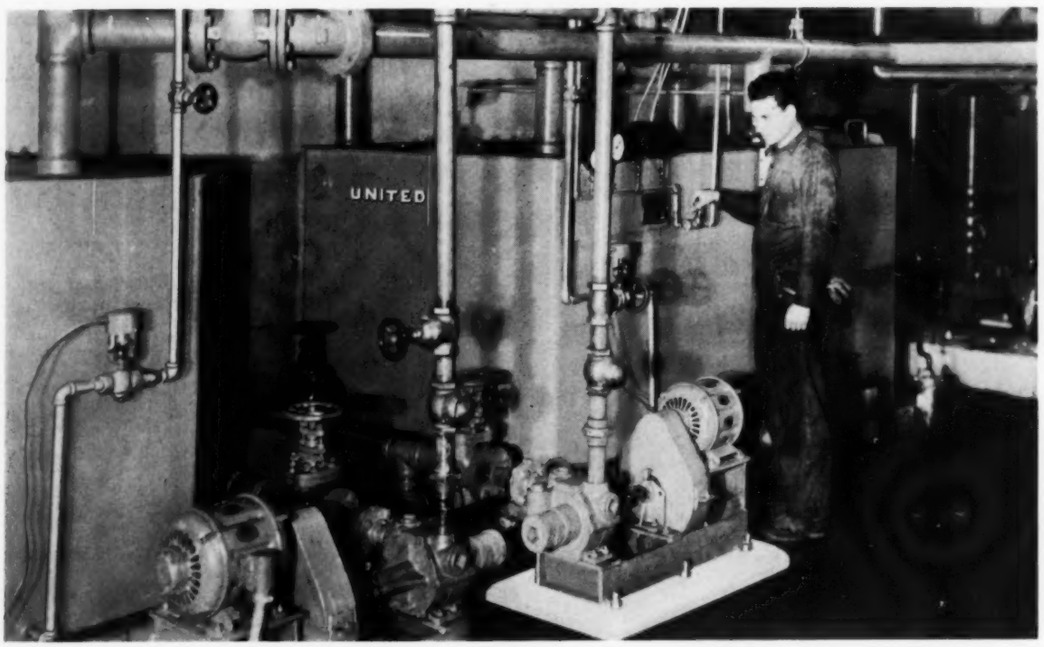

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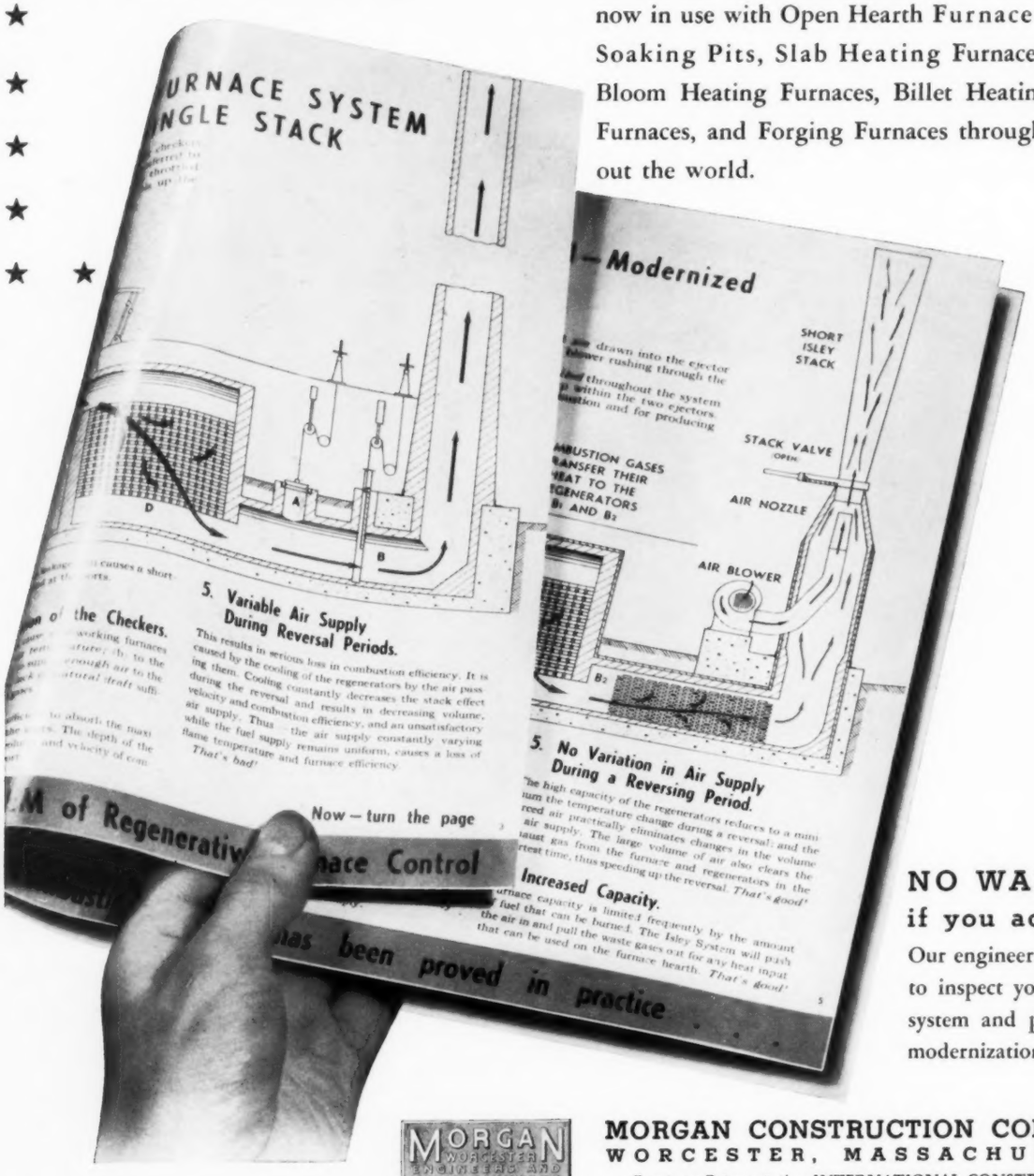

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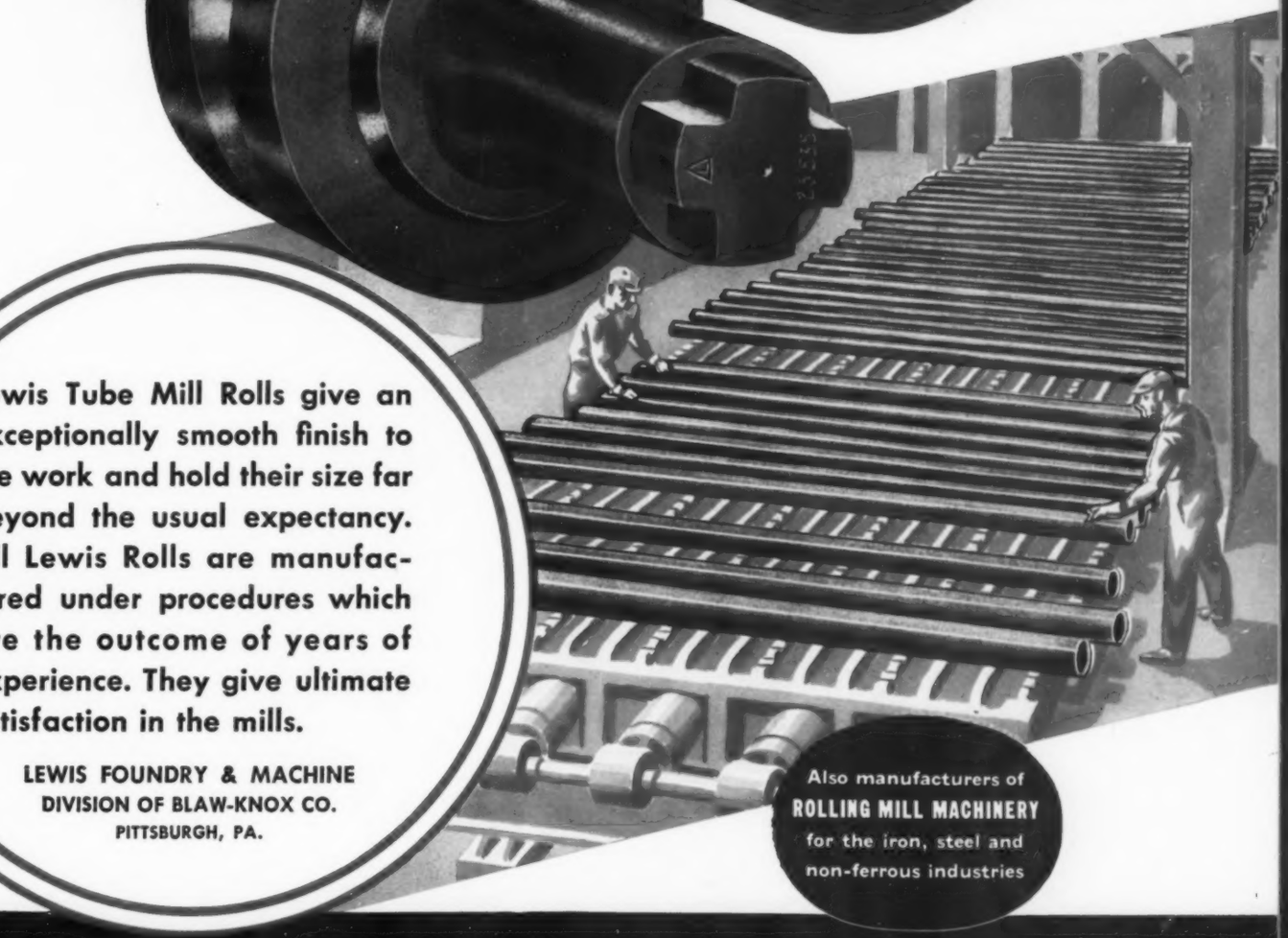

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IRON AND STEEL ENGINEER

MARCH • 1942

VOL. XIX NO. III

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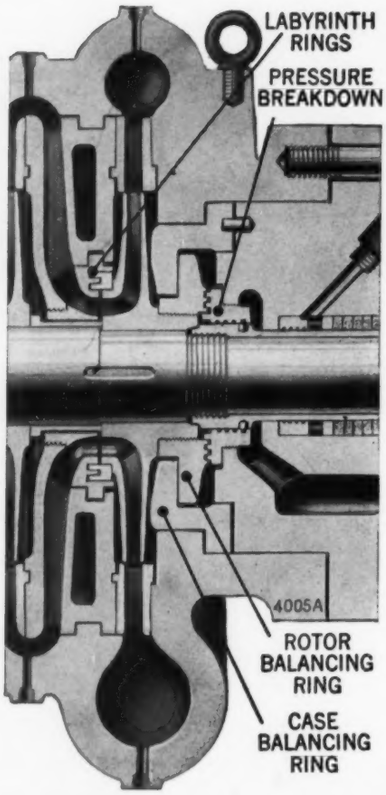

Section showing De Laval Labyrinth Rings and Hydraulic Balancing Device.

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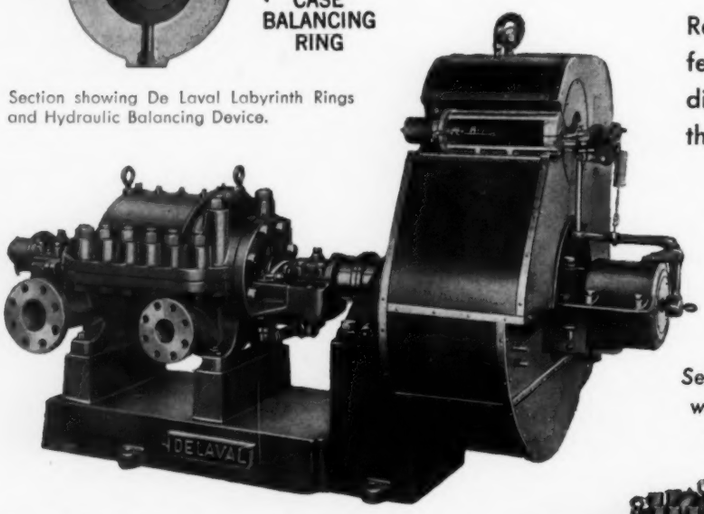

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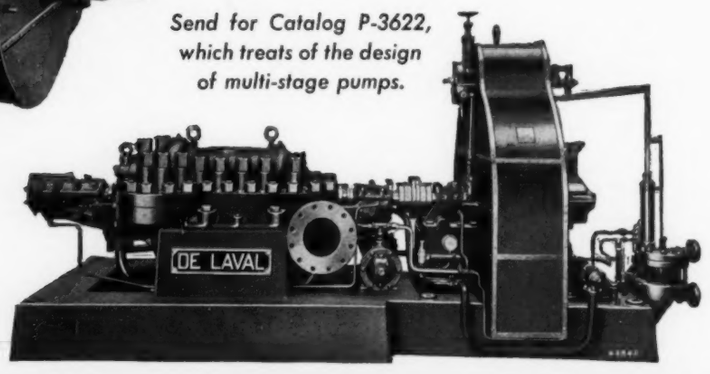

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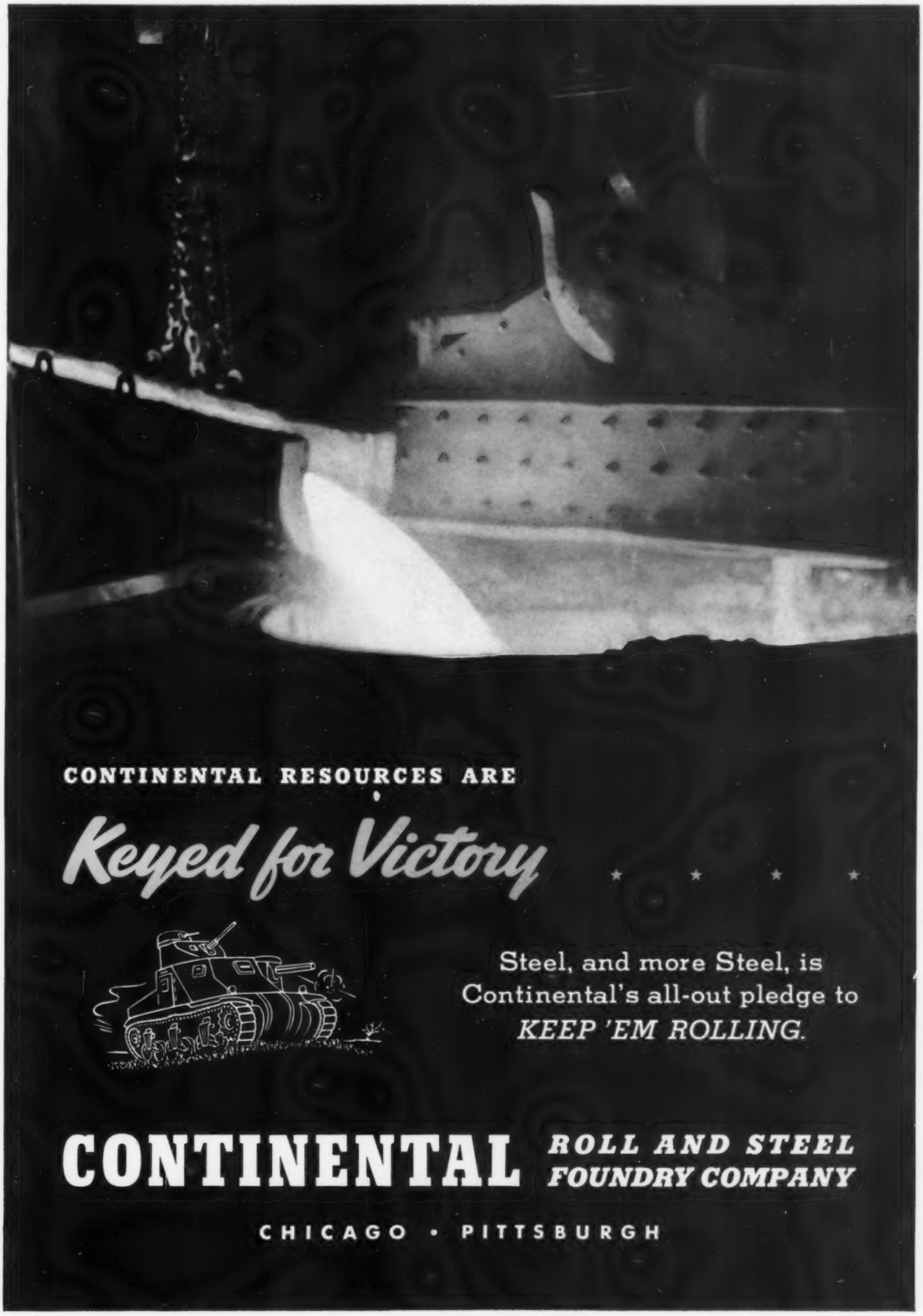
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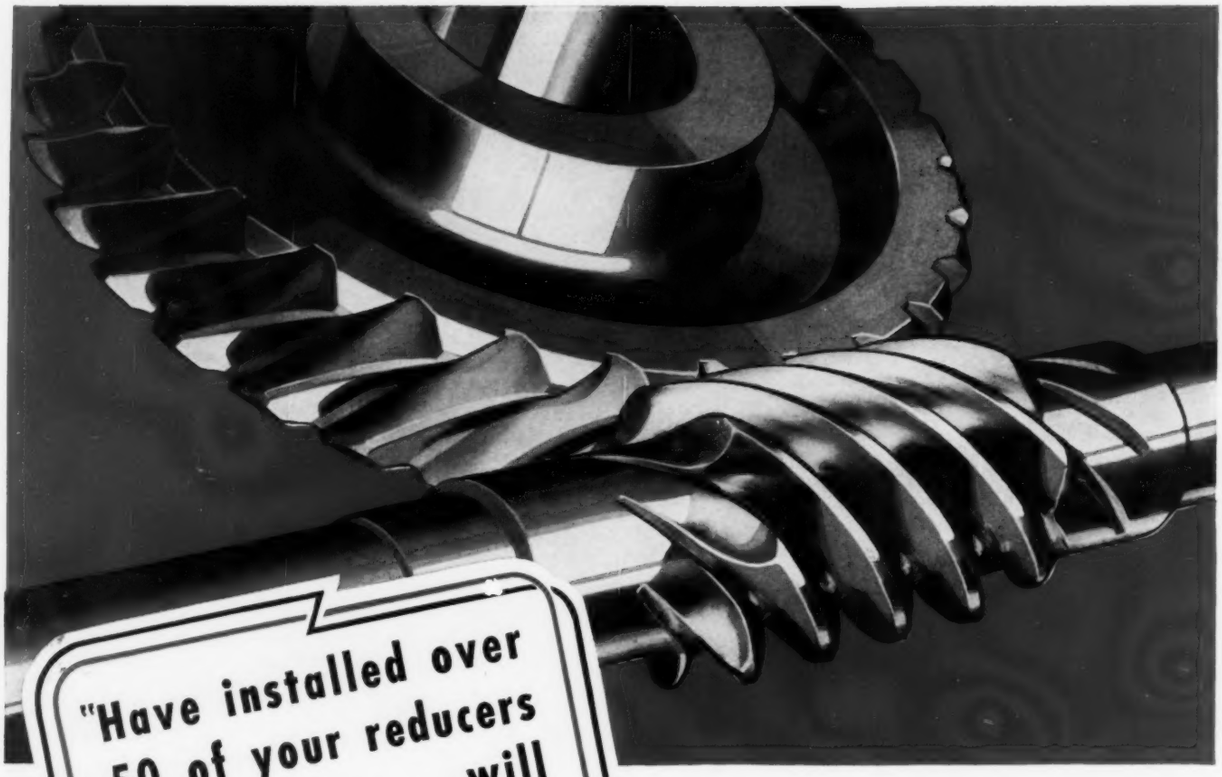

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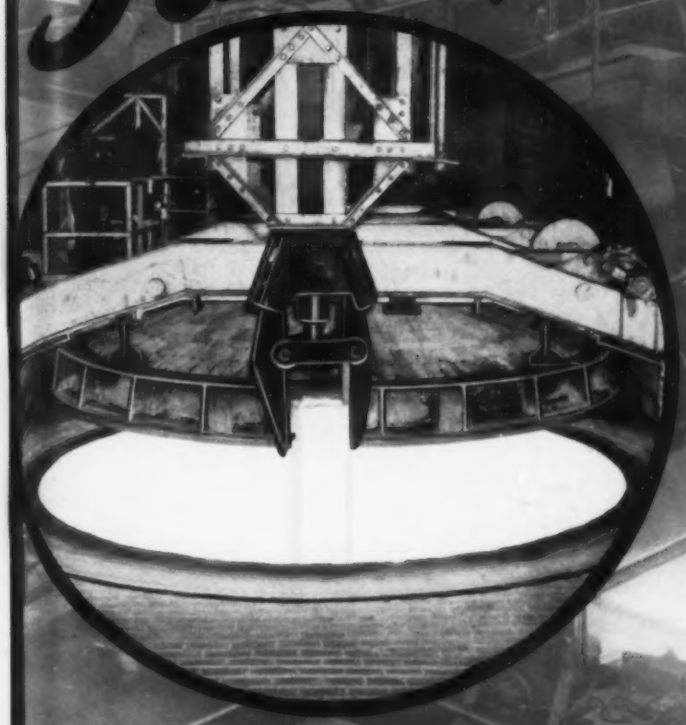

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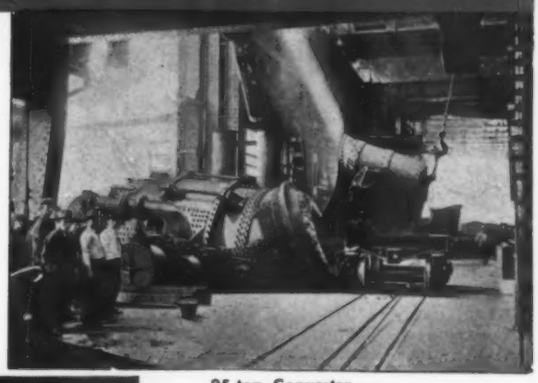
600-ton Mixer



25-ton Converter

These pictures give but small evidence of Pennsylvania Engineering Works' contribution to the Steel Industry.

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Blowing Charge in 15-ton Converter

Installations of some of the illustrated equipment at

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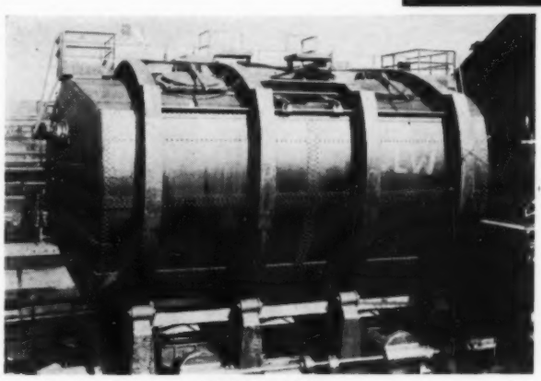
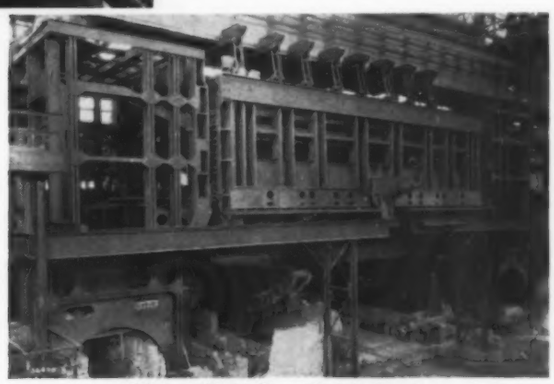


1500-ton Mixer



400-ton Tilting Open Hearth Furnace

Pennsylvania Engineering Works
New Castle, Penna.

Design, Operation and
BESSEMER CON

Mr. Loughrey, Assistant Superintendent, Bessemer and Open Hearth departments, Jones and Loughlin Steel Corporation, Pittsburgh, Pennsylvania, the author of this paper, selected the twelve color photographs reproduced on the accompanying insert from a great number of views of the Bessemer flame.

▲ MANY years ago, before the advent of modern education and psychology, it was not uncommon among a great many fine families to have at least one child who seemed destined from the very beginning to become the scapegrace of the family. He was likely to be headstrong and uncontrollable by any method then in use, and being misunderstood, he was often endured as long as possible and then cast out of the family circle as being hopelessly "addlebrained." In the few instances where this sort of person was properly guided, he became a genuis, as did Thomas A. Edison. In most cases, however, he became a "black-sheep."

Shortly before the Civil War, the first "child" in the modern family of steel making processes came into being. From the very beginning it presented difficult problems of uniformity and control, but it so far surpassed anything previously known, because of its terrific speed and lack of any competition, that its success for many years became assured.

However, as time went on, more complacent and easily controlled sister processes joined the family and the bessemer process began to lose its popularity. It had inherent defects with which the limited scientific means at the disposal of earlier steel makers could not successfully contend. Since modern scientific means have become available, little effort has, until very recently, been made to apply them. The unpopularity of the bessemer process lies mainly in the fact that it was born fifty years too soon.

Let us suppose, for example, that the Wright brothers had made their first airplane flight on the same day in 1855 that the bessemer process was patented. For many years thereafter there would be no radio communication, no directional beams for blind flying, no illuminated airports, no accurate weather predictions—in fact none of the things which make the art of flying practical. It is inevitable, then, that the airplane would have languished as a plaything for dare devils, to be exhibited at fair grounds and similar places over a period of many years and probably would have been thoroughly disreputable before science could have come to its rescue.

There are no scientific problems now apparent, either chemical or mechanical, in connection with the bessemer process which appear nearly so formidable as those already solved in the field of aeronautics, and the rewards might well be, as in the field of aeronautics, very great.

In preparing this paper, a broad description of the design, construction, and operation of a bessemer converting mill has been attempted, in order to present as complete an introductory picture of the process as is possible. The space allotted does not permit of a detailed technical discussion of the mechanical or metallurgical features involved, but if a desire to learn more of this process is aroused, the paper will have amply achieved its purpose.

LOCATION AND LAYOUT

In planning a modern bessemer converting mill a great amount of thought should be given to the location in respect to other interrelated units, such as open hearths, if duplexing is contemplated, blast furnaces, mixers, strippers, soaking pits, and slag dump. Distances should be kept to an absolute minimum, bearing in mind, of course, the relative values in each case.

Since it is more desirable to transport molten iron or slag over long distances than duplex metal or ingots, the converting mill should be located as nearly adjacent as possible to the open hearths and soaking pits, rather than a compromise with the blast furnaces and slag dump. The mixers should be considered an integral part of the converting mill, since cost advantages are considerable if the transfer of molten iron can be made

...ound Construction of a CONVERTING MILL

By D. R. Loughrey

from the mixer to the converters in one operation by means of a crane or lorry car. Although distances are a most important consideration, the converting mill should not be crowded into a small space in order to achieve this end.

In laying out the mill itself, the expected tonnage of duplex metal and ingots, with the percentage of each, must first be ascertained. The possible tonnages of bessemer and low manganese basic irons must be correlated with the open hearth, duplex, and blooming mill capacities. It is most desirable to be as flexible as possible with respect to ingot and duplex facilities in order to be able to take advantage of changing economic conditions, order book situations, and managerial desires.

Other considerations being equal, there is no reason why much larger converters than are now in use in this country would not be perfectly feasible. Just as good steel is being produced in twenty-five ton vessels as is produced in ten ton vessels, at less cost, and with a better chance of uniformity. Fifty and sixty ton converters of the basic type are being used successfully in Europe. A twenty-five ton converter has an effective bottom area of about 63 square feet inside the vessel, with a diameter of 9 feet. To get the same bath depth in a fifty tone converter, only a 13-foot inside diameter would be necessary, or a 16-foot outside diameter, in place of the present 12-foot vessel. In fact a vessel just twice the size of the present twenty-five ton vessel would not stagger the present day imagination to any extent and would produce four times the product. These facts are mentioned to show that one should not be limited by present practices in considering future installations.

Having decided upon the size and number of converters best suited to the tonnage desired and the space available, considerable thought should be given to the general layout. Herein lies the difference between a smoothly operating and efficient unit which can be kept clean and in repair while operating, or one which will be forever costly and a constant problem to the management and to those responsible for its operation.

There are two general types of layout in use in modern converting mills. The first type is where the iron is carried by a crane from either a hot metal buggy or directly from the mixer and is dumped by the crane into the vessel. In this type of mill an elevator is provided between the vessels, which carries scrap loaded in small dump buggies to a covered platform high above the vessels. This platform is equipped with a chute for each vessel which can be revolved so that the end of the chute enters the mouth of the converter, when it is in the vertical or "blowing" position, and the necessary amount of scrap dumped in. A heavy floor is provided behind the vessels to protect the scrap-loading crane and to provide a working place for the men who blank the tuyeres in the converter bottoms. The elevator, chutes, and floor are necessarily close to the converters, thus rapidly collecting heavy skulls and vessel spittings; the same condition applies to the crane runway.

The second type has a charging bridge running in front of the converters. The molten iron charge is

Modern research and development has contributed much to the economical operation and improved practice of the bessemer process.

carried in a ladle on an electric dump-type car from the mixer to the converter. With this arrangement, the scrap is loaded at the opposite end of the bridge into a similar dump car and put into the converter immediately preceding the molten iron, while the converter is in a horizontal position. A gantry type crane is used to service the vessels and clean up the mill, thus avoiding a permanent runway over the vessels. The tuyeres are blanked from an electric car which can be moved behind the vessels on a track resting upon open structural work. This arrangement presents the least possible amount of structural work on which to have skulls accumulate; a mill of this type is considered to be the safest, cleanest, and cheapest to operate, although it requires more space than the crane charging type of converting mill.

While it is obviously impossible to cover all of the multitudinous details in the layout of a modern mill in a paper of limited scope, an attempt will be made to outline the most important ones. It should be remembered that a converting mill has three undesirable operating features in a greater degree than most any other manufacturing process. These are heat, light, and dirt.

The CO gas evolved in large amounts within a converter burns to CO_2 as it leaves the mouth, causing a long brilliant flame which radiates great quantities of heat. In a closely boxed-in mill this becomes a serious operating problem. One such mill on a hot day showed temperatures of 165 F in the crane cabs and 145 F in the operating pulpit. It may be necessary to protect the surrounding residential neighborhood by shielding the brilliant glare of the flames, but the shields should be kept as far as possible from the vessels.

The dirt disposal problem is of major importance, and the mill should be designed to take care of it. From 3 to 5 per cent of the total iron blown may be thrown out through the mouth of the converter in the form of heavy skulls, consisting of iron oxide and slag, which adheres, while still molten, to buildings, shields, cranes, scrap chutes, or any other structures in the immediate vicinity. If these obstructions can be kept far enough away, this material will cool sufficiently to prevent matting before striking the ground, and will take the form of small bubbles resembling black sand which can readily be lifted with a magnet and returned to the blast furnace. Broad-gauge cinder-pan cars should be made easily available to catch the slag dumped from the converters, and the facilities for handling ladle slag should be the same as in a modern open hearth pit. It is of utmost importance that broad-gauge tracks lead directly into the mill so that the slag, refuse, and converter scale can be disposed of by rail car without double handling. Supply bins and dig-out racks for vessels and bottoms should likewise have broad-gauge railroad service.

Additional copies of the color insert opposite this page are available upon request. Address Iron and Steel Engineer, 1010 Empire Building, Pittsburgh, Pennsylvania.

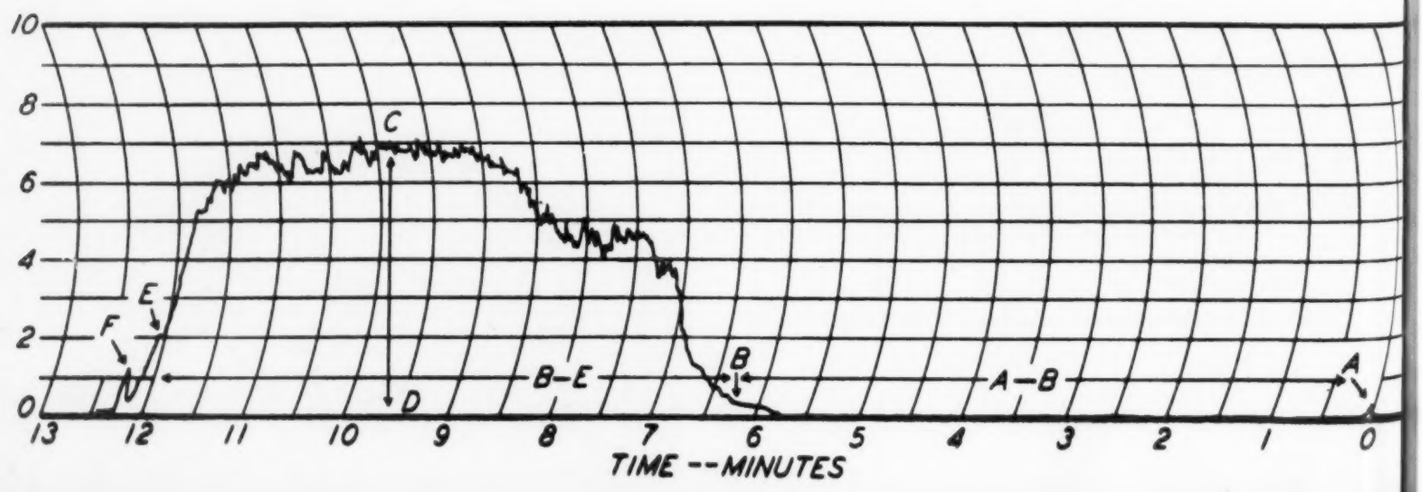
In a converting mill which produces 60,000 net tons of duplex and 40,000 net tons of ingots per month, the following railroad material can be expected to be handled:

60 cars of converter scale and slag,
50 cars of cooling scrap,
15 cars of converter and bottom lining refuse,
12 cars of alloys and miscellaneous material,
12 cars of ganister,
8 cars of tuyeres,
8 cars of tile brick,
4 cars of clay,
4 cars of converter lining stone,
2 cars of ladle brick,

or a total of 175 cars.

There are many different arrangements of the various units comprising a converting mill which might be considered satisfactory, so long as the importance of each unit, in relationship to all the others, is kept in mind. An ideal arrangement for any given plant could be set

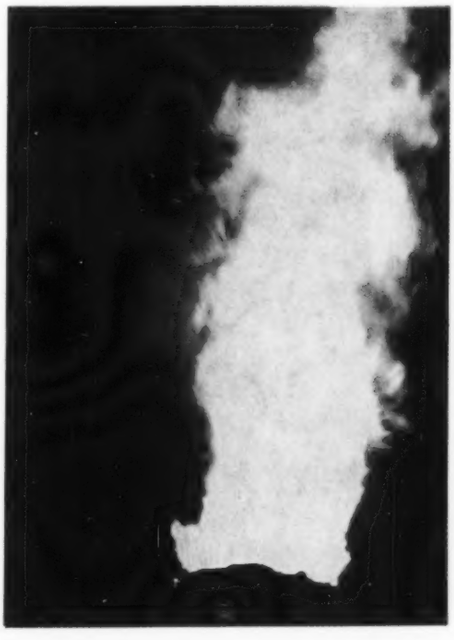
Chart from photocell installation registering intensity of bessemer flame. A—Vessel turned up. B—End of silicon oxidation and beginning of carbon oxidation. C—Maximum intensity of flame. E—First, or high carbon, end point. F—Vessel turned down. The C-D line is a relative indication of temperature. A-B represents the silicon phase of the blow, and B-E is the carbon phase.



Reproduced by four color process
from Kodachrome 35 mm. transparencies

Bessemer flame at the start of the blow. Sparks break far away from flame at the start of silicon oxidation. Flame is almost transparent. Taken shortly after point A, photocell chart.

Sparks breaking close to flame, showing approximate end of silicon oxidation. Flame becoming opaque due to start of manganese and carbon oxidation. Taken at point B, photocell chart.



Close-up of flame from hot heat. Body of flame is a solid brilliant white, with feathery edges, indicating that temperature reduction is necessary. (1/100 sec, f-12.7, indoor type film).

Close-up of flame when temperature is being reduced by introduction of steam. Feathery edges begin to disappear and dark areas appear in the flame. (1/200 sec, f-12.7, indoor type film).

PICTORIAL PROGRESS OF BESSEMER BLOW

Iron and Steel Engineer, March, 1942

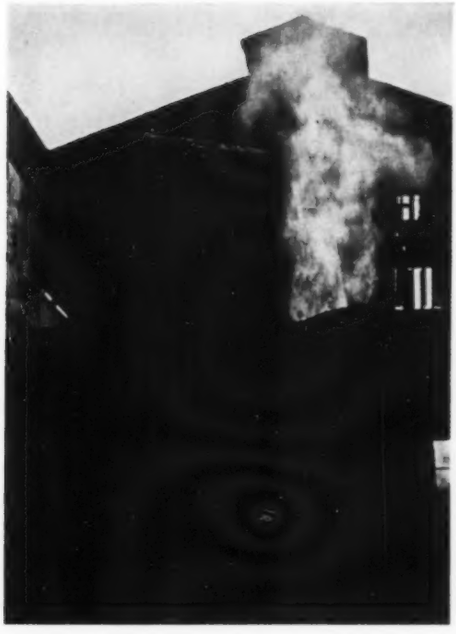
Flame lengthening and becoming whiter due to increasing temperature and rate of carbon removal. Typical iron sparks, or blooms, continue down to 1.80 per cent carbon content.

Temperature of flame is reduced by introduction of steam into blast line, producing dark areas in the flame. Temperature control should be accomplished early in the blow to prevent residual silicon.

Close-up of flame when proper temperature has been attained, as indicated by the golden color and approximate balance of light and dark areas. (1/100 sec, f-12.7, daylight type film).

The flame begins to shorten just ahead of the first, or high carbon, end point. Flame loses brilliancy rapidly due to approaching end of oxidation. Taken just ahead of point E, photocell chart.

From "The Design, Construction and Operation of a Bessemer Convertor Mill," by D. R. Loughrey



The long flame, with light and dark areas about even, indicates a proper temperature at this point. Very few iron sparks present, indicating transition into steel (approximately 1.80 per cent carbon).

Carbon being removed rapidly. Flame has attained maximum length and brilliancy. Typical steel sparks at this point, solid rather than sparkling. Taken at point C, photocell chart.

Close-up of flame at the actual first end point. Carbon content about .06 per cent. Momentary increased brilliance at mouth of vessel. Sparks now appear heavy, dropping straight down. Taken at point E, photocell chart. (1/20 sec, f-6.3, indoor type film).

Close-up of flame just before final, or screw stock end point. Carbon content about .04 per cent. White carbon lines almost gone. Sparks appear very heavy. Taken between points E and F, photocell chart. (1/20 sec, f-5.6, daylight type film).

up only after the positions of the related units were known. However, it would be of interest to briefly describe here a modern type of each unit and the role which it must play in the operation of the mill.

THE HOT METAL MIXER

The hot metal mixer, being the reservoir from which the converting mill draws its supply of iron, is highly important. In plants where both bessemer and duplex metal are blown at least two mixers are required, with an additional direct pouring spout for use when a mixer is being relined or repaired. The total capacity of the mixers used exclusively by the converting mill should not be less than the iron required for an eight hour turn. Any additional capacity beyond this minimum will often prove to be valuable.

Where space permits, the mixers can be included within the converting mill itself, which permits iron to be weighed out by the regulators on the operating pulpit directly into the iron ladle which is handled by the converter crane, or, in the case of mills which have a charging bridge in front of the vessels, by the electrically driven car.

Modern mixers are electrically operated and are so designed that the iron enters the mixer either through a hole in the roof or through a spout, thus preventing it from striking the lining on the side and eroding it. Bottom erosion may be prevented by retaining a quantity of iron in the mixer at all times to act as a cushion against the cutting action of the stream entering through the pour-in hole. Mixers are generally lined with mica-schist rock or various kinds of refractory brick. A basic brick burned to a periclase mineral texture has recently proven successful.

The necessary temperature of the mixer can be maintained by relatively small gas burners entering through the sides near the roof, or even through the roof itself. Skimming arrangements of varied design are used to prevent the kish in the blast furnace ladles from entering the mixer. This kish will cause violent slopping with a resulting lowered yield and unsatisfactory product in the converting mill.

THE VESSELS

The operating vessels should be arranged in a straight line with sufficient space between them to allow for for scrapping facilities. Also sufficient space should be provided to do the necessary manual work around a vessel with reasonable comfort and safety, while the adjoining vessel is in operation.

The distance of the vessels from the operating pulpit is limited by the minimum distance which will allow the men on the pulpit to work in comfort and the maximum distance which will give them sufficient visibility. In the case of twenty-five ton vessels, this is roughly a minimum of about 50 feet and a maximum of about 150 feet. With smaller vessels this distance is somewhat smaller, and with larger vessels somewhat greater.

The vessel itself consists of a heavy steel shell riveted together, with a nose casting bolted to the upper end. The entire vessel is keyed near the center to a cast trunnion ring which is supported by two heavy trunnions. In this way converters with eroded linings may be removed to a repair stand and replaced with newly lined shells in very short time by the simple expedient of knocking out the keys and lifting the vessel by means of the heavy converting mill crane.

One of the trunnions is hollow and is connected to the wind-box on the bottom by means of a "goose-neck" pipe, through which the blast is carried to the tuyeres. To the other trunnion is keyed a large ring gear which connects with the motor drive mechanism revolving the vessel.

It is highly important to have an extra shell so that this interchange of vessels can be accomplished, thus saving the long delay necessary for relining an operating vessel.

The repair stand is similar to an operating stand, having the trunnion ring and motor drive, but without the facilities for receiving blast. It should be located within reach of the converting mill crane and with easy access to refuse cars, stone, mud supplies, etc.

The vessel shell is lined with either mica-schist rock or white sandstone. In some cases the sandstone is used in the shaft of the vessel and the mica-schist in the nose and shoulder. This is for the reason that the mica-schist is costlier, but withstands erosion somewhat better. A great variation in lining life is found in different plants; in a twenty-five ton converter it should last for from 30,000 to 50,000 tons of steel blown. During this campaign, it is generally necessary to replace the nose and shoulders several times.

The rock lining is held in place by a bonding compound made of high silica ganister rock and a good bonding clay ground with added water to a plastic consistency. After the lining is completed it is thoroughly dried and baked.

The detachable vessel bottom is rammed against the vessel by means of a hydraulic or electrically operated oil jack, and has a mud joint between the vessel and bottom to act as a seal. It is held in place by means of large T-headed key bolts. The bottom consists of a wind-box (to which the blast pipe is bolted), the wind-box cover, bonnet, tuyere plate, and false plate. The sides of the bonnet which come in contact with the shoulder of the vessel are lined with mica-schist and do not need to be replaced with every renewal of the tuyeres.

The number and size of the clay tuyeres vary in different plants; with twenty-five ton vessels they are generally about 36 in. long and 6½ in. in diameter with either ten ½ in. holes or seven ⅝ in. holes running through them. The tuyeres are thirty-five in number and are arranged concentrically in circles in the bottom. The number and size of holes and the arrangement in the bottom have a marked effect on the blowing of the iron, and further experimentation in this connection will probably prove profitable.

The tuyeres are supported by the tuyere plate and are reinforced throughout their length by tile-brick and mud. The mud is made of highly siliceous ganister with a bonding clay, and ground with added water. It can either be poured like concrete around the tuyeres or rammed in place. The bottom is then put in a gas-fired oven and baked for forty-eight hours. The average

life of a bottom is generally between 30 and 40 heats. During the life of a bottom, the cover plate may be removed when desired for inspection of the tuyeres or to blank off any which may have been prematurely destroyed.

The mill should be equipped with at least seven bottoms, including the bonnets, tuyere plates, and false plates, for each operating vessel, in order to allow sufficient time for repair and baking. In making a new bottom the wind-boxes are unbolted from the remainder of the bottom and do not enter the drying ovens, so only two of these are required for each operating vessel.

BOTTOM HOUSE

The bottom house is generally located close to and preferably behind the vessels so that bottoms may be easily transported to and from the vessels. It is best served by broad-gauge tracks and should have ample storage space for ganister, clay, tile-brick, and tuyeres. The dig-out rack for removing the old tuyeres and tile from used bottoms should be so situated that the material will fall directly into a railroad car. The crane must be sufficiently strong to handle the full bottoms safely, since these bottoms weigh approximately the same as the normal charge of the vessel being used.

The drying ovens are gas or coke fired, with proper stacks to carry off the moisture and a temperature control effective between 200 F and 700 F. They should have a drying capacity sufficient for two-thirds the number of bottoms in use.

At least two ample sized grinding pans with hopper-charging and plow-discharging features should be provided.

OPERATING PULPIT

The operating pulpit is preferably located slightly above the charging level of the converters, in a place offering maximum visibility and comfort for the men. From here the blower controls the progress of the blow, including the movement of the converters, the operation of the turbo-blowers, the amount of air blast and steam, converter and ladle additions, water on curtain walls, signal devices for safety, and other necessary mechanical movements. It must contain facilities for keeping records, pressure and flow gauges, blast and vessel control levers, and all other equipment within easy sight and reach of the operators.

TURBO-BLOWERS

The science of pneumatics as applied to a bessemer converter has in recent years brought a great improvement in this phase of the process. The old blowing tub is being rapidly replaced by the more efficient steam or electrically driven turbine; blast systems are being streamlined, and control valves are being changed to reduce pressure losses. Work being done by Messrs. Fulton, Trinks, and McCaffry in this country, and other men abroad, has contributed to a more thorough understanding of the subject.

In the operation of a converter it is necessary to regulate the pressure between the minimum necessary to keep the iron out of the tuyeres and the maximum which can be used without causing the ejection of material from the mouth of the converter. Roughly this is between 20 and 30 psi.

It will be found that with a constant pressure, the volume of air entering the bath will drop from the initial high point as the blow begins—in the case of a twenty-five ton converter about 35,000 cfm—down to 28,000 cfm, and will return slowly to the original flow as the blow progresses toward completion. This arises probably from the fact that during the early part of the blow there tends to form chilled iron growths, resembling stalagmites, around each tuyere hole; this cuts down the effective area of the hole. These growths melt off as the bath becomes hotter. It is also possible that the oxidation of silicon forms a viscous slag on the tuyeres and this retards the flow of air.

Mr. J. S. Fulton has worked out the following rule-of-thumb method of determining the blast necessary for the operation of a converter:

(1) A seven $\frac{5}{8}$ in. hole tuyere is equal to one gross ton of production.

(2) Such a tuyere is equal to 1,100 cfm of intake air at 28 to 30 psi pressure at the pulpit.

In specifying blowing units for a new converter installation there are two major points to keep in mind:

(1) Each converter should have its own individual turbine, interconnected where possible with some other unit, such as a blast furnace turbine, which could be used as an emergency source during repair periods. Such a unit provides absolute control of pressure and volume without interference from another vessel, thus insuring a more uniform product.

(2) It is essential to have ample blast capacity. There is generally a tendency to save installation costs by purchasing blast turbines which will just barely be sufficient when new and working at maximum efficiency. Such a blower will not furnish the necessary blast when the machine is due to be overhauled. Any lack of pressure at this stage will be sufficiently costly in destruction of bottoms and in operation delays to pay the initial cost many times over.

The turbines should be located relatively close to the vessels in order to prevent loss of pressure and temperature and also to prevent condensation of water in the blast line. In cases where the source of steam supply is a long distance from the converting mill, it would probably be more desirable to install motor driven turbines close to the vessels than to use steam driven turbines and carry the blast through excessively long lines.

An important part of the turbine equipment is an adequate signalling system between the turbine house and the operating pulpit which will warn the operators to lower the vessels quickly in case of an impending blast failure.

CRANES

Where the layout of a mill requires the charging of the hot metal into the converters by means of a crane, it is of the utmost importance to see that a sufficient number of these cranes are installed and that they are of proper design. There is probably no place in the industry where electric cranes are subjected to rougher use than those operating over a converting mill; ruggedness, speed, and protection from heat and dirt are, therefore, essential considerations in the crane installations.

The duties of these cranes are to change vessels, charge molten iron into the converters, charge wash scrap which is too large to go down the scrap chutes, pull skulls from the noses of the vessels, lift replacement parts during major repairs to the driving machinery, transport patching materials and alloys, clean up skulls and scale from the converters, and various other miscellaneous jobs. In order to accomplish this, with sufficient time to service and repair the cranes themselves, one crane for each operating vessel should be provided.

The principal features of design to be carefully considered are:

(1) Roller bearings can be used at all points with the exception of the bridge track wheels, where brasses should be used. Heat warpage of the runways plus abrasive dirt do not favor roller bearings at this point.

(2) All motors, cables, gears, controllers, relays, etc., must be protected, insofar as it is possible, from heat, dust, and fumes.

(3) In order to avoid excessive equipment cost, it is generally desirable to effect a compromise between crane capacity and speed. For instance, a crane serving twenty-five ton converters must be able to lift a converter shell and lining, which weigh 100 tons, or even 125 tons if the converter contains a heavy salamander; the crane must also have sufficient speed to carry twenty-five ton ladles of iron to the converters and dump them without delaying the mill. Likewise, the auxiliary hoist must be strong enough to tip the ladle and to pull heavy skulls from the converter noses, yet be fast enough to use a magnet efficiently. To do this, a sixty ton crane having a safety factor of 10 in both the gearing and cables, with a hoisting speed of at least 40 fpm when carrying the twenty-five ton ladle, and a speed of 28 fpm under full load, with a twenty-five ton auxiliary, has been found to be satisfactory. The speed of the auxiliary hoist should not be less than 50 fpm. When the extremely heavy lift required to change vessels is necessary, the brake bands can be tightened temporarily.

POURING PITS AND LADLES

Bessemer pouring pit practice follows essentially that of a modern open hearth. Plants designed to pour 40,000 to 50,000 net tons of ingots per month should be supplied with two identical cranes, one of these to be used for servicing ladles and moulds as well as for clean-up work, at the same time being available in emergencies to pour steel.

The iron and steel ladles are lined similarly to open hearth ladles. In a mill using twenty-five ton ladles, and producing 60,000 net tons of duplex and 40,000 net tons of ingots, the ladle equipment should consist of five iron ladles, seven steel ladles, and twelve duplex ladles. It is an advantage to have the iron and steel ladles designed identically so that by removing the tilting lug from an iron ladle and adding a stopper rigging and nozzle plate, it can be converted quickly into a steel ladle, and vice versa.

Mould equipment can be used interchangeably with the open hearth so long as a sufficient quantity is provided to allow for a proper cooling interval. If no water spray is available, this interval is generally about 8 hours.

OPERATION

It is interesting to note in the past few years the increasing attention being given to the rehabilitation of the bessemer process. From a purely scientific point of view it is only natural that an attempt should be made, in the light of present day research possibilities, to remove any major industrial process from the realm of the arts, subject to the varying degrees of skill of the master operator. As no two human beings are identical, neither is the product of their skill identical. This in itself would constitute a challenge to research. Whether it be baking bread, brewing beer, or making steel the craftsman has given way to the scientist, and generally with beneficial results. However, let us examine the bessemer process to see if there is an economic feature to the problem which can render the scientist's efforts fruitful.

This process, using as it does scarcely over 10 per cent of the metallic charge as scrap, is actually more than self-supporting in this respect, and therefore can be considered as a scrap producer. During the early life of the process the major portion of steel tonnage was used for rather durable purposes, such as bridges, railroads, and large buildings. Then as time went on the advent of the motor car, the canning industry, and many other uses for steel having a relatively shorter life, created huge volumes of scrap. It is probable that this surplus of scrap had much to do with the phenomenal success of the open hearth for melting. Using 50 to 60 per cent scrap, the open hearth not only was favored by this condition, but was an absolute necessity.

The advantage enjoyed by the open hearth process may be challenged soon, and the return of the pendulum seems imminent. Per capita consumption of steel cannot be expected to increase to a large extent—in fact there is every indication of a net decrease. A greater percentage of steel is being weather proofed, either through its chemical composition or by means of protective coatings, and in other ways made more durable. Large stocks of scrap which were accumulated during the depression years have been greatly depleted by export and recent consumption. Each day sees more and more steel diverted to defense needs where it will either be shipped to Europe or will be applied to military and naval armament of a very durable nature. This situation, which is likely to continue for some time to come, favors a rapid process with a small scrap require-

ment and is limited only by the capacity of the blast furnace to supply iron.

Some of the properties of bessemer steel, such as stiffness, weldability, and machinability, are highly desirable, but other features, such as embrittlement after cold work and sensitivity to aging, have reacted against it. Then again, it has been customary to blow well on the hot side in order to avoid ladle skulls, thus increasing the pipe, laminations, porosity, segregation, and nitrogen. Many of these ills were formerly blamed on phosphorus, and a good many investigators spent considerable time hunting for some mixture to put into the steel in the belief that it would cure the ills as quinine cures malaria. Present day investigators, however, have shown that the process needs, first, larger individual heats for uniformity, and, second, finer control of the details of operation.

The operation of a bessemer plant unquestionably has its beginning in the blast furnace. Present day variation in iron cannot always be remedied in the mixer. If a 15-point variation in silicon could be substituted for the present 60-point variation, and the methods of desulphurization and dephosphorization could be perfected and applied, the problems would be greatly simplified. Specifications for a good bessemer iron are generally as follows: silicon, 1.10-1.60 per cent; manganese, .40-.50 per cent; sulphur, .25-.40 per cent; phosphorus, .090 per cent maximum.

The middle of the ranges in silicon and manganese produces an iron of roughly 2.5 to 1 ratio which is easy to control in temperature, has the proper amount and consistency of slag, and will neither scour out nor build up the linings of the vessels excessively. High manganese tends to produce a watery slag which will not stay in the vessel, while the metal is being poured out, and will help to erode the lining of the vessel badly. High silicon produces a hot blow, the temperature of which is hard to control. It is often accompanied by slopping due to the excessive quantities of superheated slag, and it tends to form salamanders on the belly of the vessel, called "kidneys." Low silicon iron will produce a cold blow with an erosive slag due to the higher content of iron oxide usually present. The temperature can be increased by "side blowing," which consists of tilting the converter sufficiently to allow several tuyeres to be exposed. The air from these tuyeres, passing over the bath, burns the CO gas within the body rather than at the mouth of the vessel, thus raising the temperature of the bath.

Strange as it may seem, there are probably more chilled heats blown from hot iron than from cold iron, especially where scrapping facilities are limited. The reason for this is that excessively hot iron, as well as cold iron, will give a flame which has the appearance of a coke flame. When the iron is cold, it is merely side-blown until the proper brilliance of the flame is attained, but in the case of hot iron there will be a small core to the flame at the mouth of the vessel which will appear blood red through blower's glasses when steam is applied. This is often called a "spider" by blowers, and the steam should be applied to it until it turns black; if kept on longer, a chilled heat will be the result.

In beginning the blow, the blower, knowing the specifications required for the finished steel and the average analysis of the iron in the mixer, calculates the charge and orders the correct amount of iron. When the molten iron arrives, the blower turns the converter to a horizontal position to prevent the metal from flowing into the tuyeres as it is poured into the belly of the vessel. The air pressure of about 25 psi is then turned on, blowing through the tuyere holes and preventing them from filling with metal as the vessel is raised to an upright position. The blast forces air through the molten iron in a fine spray. Chemical reactions between the oxygen in the air and the metalloids in the iron start immediately.

There are a great many text books and technical papers available which show the details of the chemical reactions and heat balances obtained during a blow, so these features will not be dwelt upon as thoroughly as would otherwise be the case. Rather it has been thought that a treatment of the practical side, as viewed by the blower himself, might prove more interesting and instructive. Bessemer literature seems to be almost entirely devoid of any effort to describe a blower's thoughts or the things which he looks for while blowing a heat. There is little wonder that this is the case when one considers that these things consist of a series of mental and optical standards which have been established in the mind of the individual and are exceedingly hard to transfer to paper. Let him who doubts this try to explain to another person how to see the face of the "man in the moon."

Since the blower is often situated in such a position that he cannot see the iron as it is drawn from the mixer or dumped into the vessel, the first chance he gets to appraise its temperature is when the vessel reaches the vertical position at the beginning of the blow. The amount of scrap which he has previously estimated to be necessary from the iron analysis is immediately put down the chute into the vessel. By doing this early in the blow, he holds the initial temperature sufficiently low to enable the silicon to be removed before the carbon. Otherwise the carbon would be oxidized first and an embrittling silicon residue would be left. If the blower is wise, he will have put in slightly less scrap than he considered necessary to obtain his finishing temperature, making the final adjustment by means of steam introduced into the blast line.

The harmful effect of steam as a cooling agent has often been argued, because of the hydrogen absorption by the liquid metal, but it has been shown by exhaustive tests (Eilender and Veit, Stahl and Eisen, October 10, 1940) that 80 per cent of the moisture is decomposed, but that only 5 per cent of the hydrogen produced is absorbed by the metal, a great portion of which is driven off as the steel cools and in later reheating processes.

The first thing to note when the vessel attains an upright position is the sparks being thrown from the mouth. If these sparks have the appearance of marbles being shot with high velocity, sometimes with a trail of smoke behind them, and travel a considerable distance from the mouth of the converter before breaking into a bloom, the silicon is high and the iron is hot. If the sparks tend to roll out in a lifeless manner and break close to the vessel, the silicon is low. This can be checked by watching any vessel when it first goes up. As the silicon is reduced the sparks lose their velocity

and keep breaking closer and closer to the mouth of the vessel.

A second indication of the silicon content of the iron is in the flame itself. While the silicon is burning out, the flame is little more than a clear vapor, through which building columns or other objects may be readily seen. The length of time elapsing before the flame becomes opaque is therefore an indication of the silicon content. When a photocell is being used this point is shown where the indicating pen begins to rise appreciably above the base line.

Shortly after the scrap is in the vessel, a small amount of steam is turned on. Through blower's glasses the flame will then have a dark green appearance with red streaks through it. So long as the streaks remain red and excess of temperature is present, but when they become black the steam is shut off. If the steam is allowed to remain on until the center becomes a solid black, there is danger that a chilled heat will result, unless side-blowing is resorted to.

As the carbon begins to burn off in larger quantities, the length and brilliancy of the flame increases, due to the more rapid evolution within the vessel of CO gas which immediately burns to CO_2 upon coming in contact with the outside air. At this point the judging of the temperature becomes a matter of fixed mental standard which has been established by the blower through experience. If the flame is extremely feathery on the edges, with quantities of smoke being given off, accompanied by a brilliant glare, especially noticeable where reflected from a floor or wall, a high temperature is indicated. Conversely, a dull flame with dark streaks showing through indicates too low a temperature.

If a small amount of steam is injected into the line in the case of the heat showing excessive temperature, the flame will take on a greenish cast, and when viewed through blower's glasses will show light green on the edges with the main portion of the flame either bright red or a salmon color with red streaks through it. The problem, then, is to cool the flame until the amount of green and the amount of salmon color are about equal, so that when the steam is turned off, the flame will have a bright golden color.

Where a photocell is being used, the height which the recording pen rises on the chart may be used as a temperature indication, so long as it is remembered that this is not a direct reading, but only relative, and the blast pressure and number of blanked tuyeres are taken into consideration.

The temperature regulation in any case, however, should be accomplished so that the correct temperature is attained by the time the iron is changed to steel. This transition point, which is shown on the iron-carbon diagram as occurring at about 1.80 carbon, is easily detected in the flame. As this point is approached, the typical effervescing iron spark is replaced by a solid spark, until, as the critical point is passed, the iron spark completely disappears.

The flame continues to remain long and brilliant until the amount of CO gas being generated in the vessel is reduced by the diminishing carbon supply, at which time it begins to shorten rapidly, indicating the approaching end of the blow. At this point the needle on the photocell chart will begin to drop rapidly toward the base line. As this occurs, the vessel should be moved to a position where all the sparks will fall in a curving arc toward the front or "turned-down" position. The flame at this point will be rapidly dropping in length and turning to a dark brown color with heavy white streaks of carbon through it. The first end-point, commonly called the "high carbon" change, will then occur. This change consists of the momentary halting of the drop in luminosity of the flame, amounting to a sort of recalescense point, and probably caused by the increased oxidation of iron in combination with the last of the carbon. This sudden change in light shading can be seen more readily if the observer will permit his eyes to focus on the territory surrounding the vessel as well as upon the flame itself. The whole change occurs in little more than once second's time and is not easy to detect; in fact some men's eyesight is not sufficiently sharp to ever enable them to see it. Immediately following the change, the major carbon lines disappear from the flame and the sparks, seeming to become suddenly heavy, fall in a straight line directly in front of the vessel. On the photocell chart a sharp shoulder is shown on the curve where its fall toward the base line is interrupted.

If recarburized steel or any of the low carbon rimming or semi-killed steels are being made the temperature and carbon content will be correct at this point; the vessel is lowered to a horizontal position and the blast is shut off. If, however, high sulphur machining steel is being made, the machining properties are apparently benefitted by increased oxidation and a lower carbon content of the metal is desired. For these reasons the blow will be continued to the "clear" or "screw stock" change.

This final change occurs about 16 or 18 seconds after the first change, depending upon the blast pressure, the number of blanked tuyeres in the bottom, and the slag volume due to the original silicon content of the iron. As the first change is passed, the carbon lines become shorter and shorter until, as the change occurs, they seem to be suddenly swallowed into the converter and the sparks instantly stop falling. At this point the converter is brought down.

When the photocell is being used this point is determined by automatically starting an electric timer as the first change is reached. This timer is set to blow a horn a predetermined number of seconds depending on the numbers of blanked tuyeres and the silicon content of the iron. When the horn stops blowing the vessel is pulled down. The higher the silicon and the greater the number of tuyeres, the longer the horn is permitted to blow. This gives a constant end-point for any set of conditions.

It should be borne in mind that different sizes and shapes of vessels as well as the prevailing irons in different plants will alter somewhat the appearances of the flame. For instance, a blower who is accustomed to blowing a ten ton converter with a relatively small mouth will almost invariably blow a twenty-five ton converter too cold. The increased volume of flame seems to give him a sense of excess brilliancy which actually is not there.

The entire blow generally takes from 11 to 18 minutes, depending upon the silicon content of the iron and the number of blanked tuyeres in the bottom. The blown metal contains only traces of silicon and man-

ganese and from .03 to .05 per cent carbon. Conversely, the phosphorus and sulphur increase proportionately due to oxidation of other metalloids and part of the iron. The loss is about 8 to 10 per cent of the charged weight, giving a converter yield of 90 to 92 per cent.

DUPLEX OPERATION

The limited scope of this paper does not permit a detailed discussion of the duplex process, except as it affects the operation of the converting mill. The process consists primarily in removing the metalloids, silicon, manganese, and carbon in varying degrees from the blast furnace iron, and the charging of the resulting blown metal into a basic open hearth furnace where the phosphorus and sulphur are reduced to the values obtained in regular scrap practice.

The blowing of this metal removes from the blower some of the burden of preciseness necessary in making finished steel, but the process has probably suffered because this attitude has been carried too far. Actually there is a rich field for research here, and recent indications tend toward rigid control of the blowing.

Low manganese basic iron is used principally for this process because of economic reasons, although bessemer iron may be used if desired. This iron is substantially similar to bessemer iron in analysis except that the phosphorus is usually carried around .200 per cent.

There are two principal types of blown metal: the low blown, used when it is intended to add molten iron in the open hearth furnace to bring the carbon to the desired point for working the heat, and the high blown, where little or no iron is added to the furnace.

Typical analyses of the two types are as follows:

	Low blown, per cent	*High blown, per cent*
Carbon	.10-.20	.60-1.00
Silicon	.005-.010	.005-.010
Manganese	.010-.040	.010-.040
Phosphorus	.200 max.	.200 max.
Sulphur	.040 max.	.040 max.
Nitrogen	.012-.018	.004-.010

There are two points to note in the comparison of these analyses other than the range of carbon, which will be explained.

(1) It will be noted that in both cases the carbon specified is above that which obtains at the first or "high carbon" change previously mentioned. This is done in order to be assured that the siliceous vessel slag will be heavy and viscous enough to remain in the vessel as the metal is teemed into the duplex ladle. Any considerable quantity of this slag entering the open hearth furnace would lower the basicity of the open hearth slag and cause the phosphorus to revert to the metal. Also, there is a further drop in the carbon content as the metal is exposed to the air both in pouring from the converter and pouring into the open hearth furnace.

(2) The nitrogen content of the high blown metal is only about half that of the low blown metal. This is because the high blown metal has not reached a sufficiently high temperature to absorb so much nitrogen and the length of exposure to the blast has been less than in the case of the low blown metal.

Insofar as the converting mill is concerned, it is more desirable to blow the low carbon metal than the high carbon. During the course of the blow there is no accurate means of determining the carbon content except at the transition point between iron and steel, occurring at 1.80 carbon, and the first change, occurring at .06 carbon. When any other carbon is desired, the judgment of the blower must be relied upon. In the case of the low blown metal, however, the desired carbon is attained just before the flame starts to drop and is therefore easier to judge.

In addition to judging the carbon content of the blow properly, it is the function of the blower to regulate the temperature so that the metal can be poured without freezing into the open hearth furnace, and yet will not have sufficient excess temperature to cause an abnormal nitrogen absorption. The proper temperature is determined by the carbon content of the metal, the distance it must be transported, and the facilities in the open hearth for dumping it. The temperature regulation and appearance of the flame is the same as for a finished blow.

Whether blowing high carbon or low carbon duplex, there is a decided tendency for a salamander to collect on the lining of the vessel due to the viscous nature of the slag produced, but in the case of the high carbon blow, this condition is very much more severe, often collecting so rapidly as to interfere with the operation of the vessel after a run of several days. The deposit is exceptionally rapid on the belly, often being 3 to 4 feet deep, extending in two rows the full length of the vessel. These are called "kidneys."

Many means have been tried to remove these kidneys from a hot vessel without much success. A pointed ram was designed to fit over the plunger head of the jack used for ramming on bottoms, and in another case a combination oil and oxygen burner was made to burn them out. A specially designed gun resembling a military field piece was developed having a 1 in. bore and firing an 8 ounce hardened metal projectile with a striking force of 9,000 foot-pounds. Five hundred of these bullets were fired into one kidney while it was still hot in the hope of cracking it, but with scarcely any visible effect.

Where the salamander has collected over the entire inside surface of the vessel, the portion on the shoulder and nose and across the back, as well as part of the kidneys, can be removed with a "cinder heat" and the operation of the vessel prolonged for several days.

This is done by charging an amount of iron into the vessel equal in weight to between 5 and 10 per cent of a full charge, depending upon the amount of salamander to be removed. A blast pressure of one-third the normal amount is then turned on and the vessel raised to an upright position. The silicon, manganese, and carbon are burned out quickly. The iron then begins to be oxidized, creating an excessively high temperature in the vessel. During this portion of the blow dense volumes of brown smoke are emitted from the mouth of the vessel. The blast pressure can be alternately raised and lowered to distribute the scouring action over the entire length of the vessel. It is well to turn the vessel down several times during the blow

and allow the superheated metal and cinder to melt the kidneys, at the same time allowing the back to cool and preventing it from being eroded too severely.

The dense fumes will continue until the oxidation of the iron is complete, at which time the flame will be short and extremely brilliant, almost blue in color. At this point, the vessel is turned down and the blast shut off. After the slag has been allowed to boil on the kidneys for several minutes, it is teemed off slowly into a ladle, with generous additions of converter scale to prevent erosion of the ladle lining. The slag is then lip poured into a slag box.

This procedure is extremely useful in cleaning out a vessel, but because of the high temperature (probably over 3500 F), and the erosive action of the iron oxide slag, it should never be attempted unless the stone lining of the vessel is in good condition. A new bottom should not be used in making a "cinder heat" as it will be eroded badly during the blow and generally will require immediate renewal.

The ultimate in converter lining life is generally achieved in plants where the tonnages of finished bessemer ingots and duplex metal are well balanced. The vessels can then be blown for alternate periods on each type of metal, the accumulation from the duplex practice being removed at least in part by the erosive action of the full-blown heats.

POURING

It can be seen from the preceding discussion that the blower, either through the exercise of his own judgment or by means of the photocell, is constantly striving to reproduce the same degree of oxidation from blow to blow, thus obtaining the uniformity which is so essential in modern products. While not so apparent, it is nevertheless true that non-uniformity from blow to blow also leads to non-uniformity within the blow itself. Most bessemer steel is either semi-killed and capped, or is rimmed. Good mould practice on each individual blow depends upon a uniform degree of oxidation from blow to blow. The steel pourer judges the condition of the heat during the pouring of the first ingot and tries to control the rate of gas evolution by means of mould deoxidizers. Over or under oxidation changes the rate of gas effervescence in the mould, so that the first ingot or two of an over-blown heat may not be properly deoxidized, with resultant bleeders and unsound interiors. Thus, as much as 50 per cent of the heat may be poured before the proper oxidation is attained. Similarly the young blown heat might have insufficient gas evolution to rim properly, with resultant subcutaneous blow holes. This variation is probably the explanation for a major portion of the undue segregation and laminations that are occasionally found in bessemer steel.

SUMMARY

It has been the broad purpose of this paper to present practical facts in the construction and operation of a modern bessemer converting mill, without attempting to single out any particular phase for detailed technical explanation nor any one problem for solution. Rather it is hoped that through discussions of this nature, more engineers and scientists whose interests and abilities have been directed elsewhere may become familiar with the possibilities as well as the drawbacks of the bessemer process.

The prime requisites of a converting mill are:

(1) Ample space in a location close to interrelated units.

(2) Ruggedness of construction to prevent breakdown delays, remembering that the principal attribute of a bessemer is its speed.

(3) Layout and equipment designed to handle supplies, product, and refuse without interference with operations.

(4) Equipment capable of producing sufficient blast at all times.

(5) Closest control on the process, with improved equipment to make this control possible.

Only to the extent that these essential requirements are realized will the bessemer process continue to hold its place as an important component part of the steel industry.

DISCUSSION

PRESENTED BY

J. S. FULTON, *Special Representative*, Ingersoll Rand Company, Pittsburgh, Pennsylvania

H. T. BOWMAN, *Bessemer Metallurgist*, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

F. F. FOSS, *Assistant to Chairman and General Metallurgist*, Wheeling Steel Corporation, Wheeling, West Virginia

H. L. McFEATERS, *Chief Engineer*, Pennsylvania Engineering Works, Mead-Penn Iron Works Company, New Castle, Pennsylvania

J. S. FULTON: The speaker can fully agree with Mr. Loughrey about the importance of giving the operator as much information as possible about the quantity and quality of all materials that come to the vessel; that is, to know the analysis of the iron and also to know the character and quantity of the air that is being received.

In his paper, Mr. Loughrey mentioned the use of quinine to cure malaria, which brings up a rather interesting simile, because actually "malaria" means "bad air." Now, I think there are more vessels that get into trouble on account of "bad air" than has been recognized before. You have to know the quantity and quality of the air to achieve best results.

In most of the vessels, as they stand now, there is entirely too much loss of pressure between the blower and the vessel body. It is found at some plants that as much as 30 per cent of the generated pressure never reaches the vessel. Take the case of a plant which the writer has in mind. They lose one pound of pressure

in 3,500 ft of line leading to the pulpit, and they lose nine pounds between there and the wind box.

Another thing that comes up is rather interesting. Mr. Loughrey described the method of burning off "kidneys." Only five or ten per cent of the weight of iron is ordinarily charged, but the charge is blown with only about one-third of the normal pressure, or about 10 psi gauge. It is the usual impression that a 30 psi blast pressure is necessary to support the liquid iron and keep it from running back down through the tuyeres. The actual pressure necessary in the wind box is a function of (1) the number of tuyeres, (2) the length of these tuyeres, and (3) the volume of air actually passing through the tuyeres.

We have just noted a plant where 9 psi gauge pressure is lost between the pulpit entrance and the wind box entrance, giving only about 20 psi gauge in the wind box as perfectly satisfactory for commercial operation. The Algoma Steel Company blew a smaller vessel during the last war with a blower capable of delivering only 18,000 cfm against 18 psi gauge. If we apply the same 30 per cent loss of pressure, this vessel would have only 12 or 13 psi gauge pressure in the wind box. The operation was successful, but the blowing time was about in inverse proportion to the 20 and 12 lb gauge pressures, or, expressed another way, the Algoma vessel was blown about twice as long.

So there are a lot of improvements to be made in the pneumatic circuit that will certainly decrease blowing power and at the same time probably improve the process as a whole. If the pulpit operator had a visible indication of the exact volume of air leaving the blower, he would have a check on leakage and so be able to interpret why a particular bottom "blow slow" with the usual "pulpit pressure," on account of excess leakage.

The more information we give the pulpit operator, the easier it is for him to produce the desired product.

H. T. Bowman: At a time when many minds are thinking of increasing steel making capacity we are fortunate to get such a practical exposition on converting mill design and construction. Mr. Loughrey has done a good job. Our obligation in discussing the metallurgical phases of this paper seems to be that of pointing out features of design that will result in improved control of the metallurgical features of the process and that will make future metallurgical investigation and research easier than it has been in the past.

We would supplement Mr. Loughrey's layout discussion with the thought that scrapping facilities be made fully adequate to meet a diversity of needs. The scrapping floor should be so protected that the men can work with reasonable comfort, thus insuring work well done. Rather than the one scrap chute per vessel mentioned by the speaker, we would like to see two, or even three. One should be so located that additions such as scale, ore, mill scrap, sulphur, copper, etc., can be made to the empty converter without damage to the bottom.

We liked the mention of a charging bridge in front of the converter. From the metallurgical viewpoint it would have several advantages—it would enable us to place a skimmer in the vessel mouth to keep the slag from running out into the ladle with the metal. This would result in higher manganese efficiency and possibly cleaner bessemer steel. It would also keep the siliceous converter slag out of the open hearth furnaces in the duplex process. The skimmer would also aid in any super-refining process such as dephosphorization. Another advantage, important from the research and investigation angle, is that the bridge would greatly simplify the matter of obtaining slag or metal tests from the converter.

The active mixer is used a great deal in England and on the continent today. While we would not go so far as to recommend an active mixer, some thought should be given to a convenient method of making additions to the iron transfer ladle for sulphur removal, or some means of adding ferrous oxide to shorten the blowing time, or other developments that may seem desirable in the future. Provision should also be made for skimming the resultant slag from the ladle.

Another item that occurs to us in connection with iron handling is that of locomotion. Considerable thought should be given to diesel, electric, or drag-line locomotion because of the freedom from smoke. Since the control for this process depends entirely upon visual observation and instrumentation, any efforts in the direction of a smoke-free mill will result in more positive control.

The mechanism for operating the vessel is important metallurgically in that a uniform rate of turn down is desired. We find that our electrically driven converter is more constant in this respect than the hydraulically controlled units. The electric drive is able to overcome the effect of balance-changing conditions in the converter lining such as kidney build-up, nose erosion, and bottom changes. The hydraulic system is sometimes adversely affected by simultaneous use of the hydraulic water in ladle hoists, elevators, or any other nearby hydraulic systems.

To insure that the operating pulpit be placed at the point of maximum visibility, we would suggest that it be air conditioned. In addition to the greater visibility offered, it will increase the comfort, and thereby the efficiency and morale of the operators.

Dephosphorization and other types of ladle purification may be a vital part of the bessemer of tomorrow. We should avoid congestion around the ladle side of the converter so that a reasonable space is provided for the installation of whatever auxiliary equipment the future may demand.

In regard to the duplex problem of kidneys, we should say that the best way to minimize this evil is to provide fast handling facilities. Kidneys are the result of progressive freezing of the converter slag to the converter wall as the metal lies motionless waiting to be poured into the open hearth transfer ladle. Our experience is that kidneys build up faster the longer the blown metal is allowed to remain in the coverter. Thus, fast, efficient handling equipment must be provided to minimize kidney trouble.

While not mentioned by our speaker, we believe that new, or rehabilitated converting mills should be serviced throughout by insulated ladles. Likewise, adequate heating facilities should be provided for these ladles so that none is ever put in service at too low a temperature.

F. F. FOSS: The paper on design, construction and operation of a bessemer converting mill by Mr. Loughrey, devoted to the "scapegrace" (as he calls it) of the iron and steel family, was very illuminating in a direct and an indirect sense and, as far as I know, the only one where color photography has been used to such an extent. Pictures presented by Mr. Loughrey give a good supplement to the spectroscopic and photoelectric cell observations of the bessemer converter flame, already known to the industry.

Because Mr. Loughrey's introductory remarks about the "scapegrace" might create a wrong impression among steel workers not well versed in history of the bessemer process, I think some remarks "whitewashing the black sheep" are in order. The brilliant career of the acid bessemer process in the United States, the only process which could be applied to raw materials of this country, was rather short-lived and, since the advent of the basic open hearth process, it has had to yield first place to the newcomer. The content of phosphorus in most American ores is such as to prevent development of the acid bessemer process but far too low to establish the basic bessemer process.

Air-blowing through a layer of pig iron, for making it malleable, which Bessemer actually invented, was not assigned only to acid lining of the converter and, after some 25 years, the same air-blowing through molten pig iron has been recreated in the converter lined with basic materials. This last modification of the bessemer process was put into life by another Englishman, Sidney Gilchrist Thomas. Since 1880, the basic bessemer process grew steadily, until annual production of "Thomas" steel reached 16-22 millions of tons in Germany, France, Belgium, Luxembourg and Russia.

Theoretical studies of the acid bessemer process started very soon after its inception and the names of such illustrious metallurgists as Görannson, Tamm, Caspersson and Akerman have been connected with the theory of the bessemer process since 1875.

The bessemer process has been adapted to conditions of five different countries and literature devoted to it contains profound studies of at least five modifications of the orginal process. There is the English process, with use of high silicon and low manganese pig; the German process, where high silicon, high manganese and high initial temperature of pig iron are used; the Swedish process, adapted for low silicon pig iron with many precautions taken to conserve initial heat of the pig direct from the blast furnace; the Russian process, also developed for low silicon pig iron, like the Swedish, but having intermediate overheating of pig iron in a separate furnace. The American modification of the process is adapted for medium silicon and manganese content and normal temperature of molten pig. Many ingenious designs of converters of different forms and types were developed.

All the above methods were covered by profound studies and hundreds of publications, witnessing the fact that the acid bessemer process has attracted the attention of many talented men who made, and are making, the best use of this process as long as suitable raw materials were, and are, at the disposal of the industry.

The basic bessemer process had still more luck in attracting the attention of prominent metallurgists of the entire world. Literature on the basic bessemer is tremendous. Particularly well covered is the study of Thomas slags. As is well known, Thomas slag pays for nearly all the cost of the converting process. Treatises on chemistry, thermodynamics and mechanics of the Thomas process constitute a tremendous library. The equipment and lay-out of Thomas plants in continental Europe and (of late) in Great Britain represents the last word in modern technique.

Flames of converters have been very thoroughly investigated by use of the spectroscope, which gave a good amount of information on the process before advent of the "electric eye."

At present, when the attention of American metallurgists has again been attracted to possibilities of the bessemer process, the results of tremendous labor which has been dedicated to the study of the processes could and, I hope, will, be used to great advantage.

H. L. MCFEATERS: Mr. Loughrey has presented a very interesting paper on the operation and design of the bessemer converting mill and has made a very important contribution to the steel making literature at a time when, due to the war emergency, the bessemer process is being given considerable consideration as a method for quickly increasing steel production.

Since the installations of the first large converters of 20-ton capacity at the plant of the Tennessee Coal, Iron and Railroad Company in 1907 and at the Bethlehem Steel Company in 1909, the designing engineers and the operators and engineers of the various steel plants have made many improvements to bessemer plant layouts and to the auxiliary equipment serving the vessels. The capacity of the vessels has been increased until now in some instances they are blowing over 30 net tons.

The converters that are now blowing over 30 net tons are almost identical in overall dimensions with the first 20-ton vessels that were installed in 1907 and 1909. The vessels originally were equipped with 25 tuyeres and where increased capacity has resulted, the practice is to have from 31 to 35 tuyeres. The additional tonnage in the same blowing time has practically all been obtained by the increase in the depth of the bath, increase in the number of tuyeres and increase in the capacity and characteristics of the blowing equipment.

The original large vessel installations were tipped by means of hydraulic cylinders, but most all recent installations are turned with a rugged herringbone gear reduction, together with a self-locking worm drive rotated by oversized d-c mill type motors with brakes, either motor having ample capacity to operate the vessel.

Dual reversing controls are used for the vessel motors, each motor having its own control panel. Double masters are provided so that they may easily be disconnected for operating either motor. Brake is provided with double series coil. One of the coils is to be connected in series with each motor of the drive, this arrangement permitting the operation of both brakes with the current from one motor or double motor drive.

While there has been no great change in design of the large vessels, the bessemer plant layout for a combination of duplex and straight bessemer has received considerable engineering study resulting in a number of interesting installations.

The auxiliary equipment serving the plant including

the cars, ladles and mixers has undergone the greatest improvement since the first installation of large vessels.

Transfer of the metal from the mixer to the converters was most generally accomplished either direct from an overhead crane or by transferring a ladle car with a rope dragout. This transfer of metal is now accomplished with an electrically propelled and electrically tipped transfer car and both the propelling and the tipping are remote controlled, increasing the speed of the operation and tending to increase the safety and eliminate accidents.

The jack car for removing and hoisting the bottoms in place on the vessel in most cases has been changed from a hydraulic operated jack car to a combination of electric and hydraulic jack car. A motor driven fluid pump furnishing oil at high pressure to a single plunger has been mounted directly on the car. The fluid motor pump is furnished with controls for maintaining the pressure of the bottom against the vessel when sealing the mud joint, the electric motor continuing to operate at its normal speed.

Instead of a number of separate drying ovens with room for one or two bottoms, there has been developed a continuous drying oven with ample capacity to serve three or more converters.

The introduction of scrap metal into the converter has been accomplished in various ways but there are now available designs of a remote controlled electrically propelled and electrically operated scrapping car traveling on the working platform. The control for these cars has been arranged so that they cannot be tipped until the car has been placed on the exact center line of the vessel. This is likewise the case for the hot metal cars.

In order to repair and blank off the tuyeres of the vessel, there has usually been provided some kind of a stationary crane convenient to remove the wind box cover when the vessel was in the horizontal position. In order to increase the speed and efficiency of this operation and at the same time protect the workmen, there has been developed a repair car, electrically propelled, traveling on the working platform equipped with a crane and the necessary repair tools. This repair car has a totally enclosed cabin to protect the men while at work.

In order to decrease the loss of time, there has been installed in a number of plants a repair stand consisting of the converter shell, trunnion ring and tipping mechanism with one motor suitably supported. This stand is not connected to the blowing equipment but is used to reline a spare vessel and the tipping machinery is available at all times for spares in case of break down.

The installation of the 20-ton vessels at the Bethlehem Steel Company in 1909 included a 1000-ton mixer, one of the first large mixers built in the United States. The mixer was installed not only to serve the purpose of mixing the iron as received from the blast furnaces, but also to provide ample storage for a continuous operation providing there was any delay in the receipt of blast furnace iron.

Since the installation of the first large mixer, there have been numerous increases in capacity and improvements in design. The latest designs of mixers provide for double tilting mechanism and double motors, either motor or either screw of ample capacity to operate the mixer, and the mixers are provided with an engine operated by air of sufficient capacity to return the mixer in case of power failure a sufficient distance to stop the flow of metal. Mixers have been built holding as much as 1700 tons of metal.

In order to guarantee an air supply at the required pressure to return the mixer in case of power failure, an independent compressor and air receiver is provided, so arranged that if the air receiver is not at the required pressure it is impossible to operate the mixer by its electric drive.

A more recent development in the shape of the mixer proper was the barrel shape mixer. These mixers have been built as large as 1300 tons and are supported on two rockers. The center to center distance between the rockers can be varied without any reinforcement to the shell, as the section of the shell between the rockers is in tension and this tension is counteracted by large tie bolts between the rockers. The advantage of these barrel shape mixers is that they are readily drained. The lining is arched in all directions, and being mounted on two wide spaced rockers, the pouring spout can be connected at the shell with a wide opening, eliminating sharp corners and pockets. It is preferable to have the receiving hopper on the top over the metal bath.

Most of the above equipment enumerated has played a part in increasing the capacity and the speed and operation of bessemer plants.

Designs of converter as large as 75 tons and mixers of over 2,000 tons have been prepared together with the auxiliary handling equipment, and there seems to be no mechanical reason why equipment of this size cannot be handled, but the large dimensions of this equipment have in the past prevented its installation in the present plants and probably these larger sizes can best be considered when an entirely new plant is designed.

As the capacity of the present bessemer vessels has been increased, it has only been accomplished by a larger blowing capacity and in order to blow over 30 tons of metal, blowing equipment of substantial capacity is required and if the proper consideration is given to the size and arrangement of all passages that transport the air from the blowing engine up to and including the tuyeres, the required pressure which is now approximately 30 psi might be reduced to as low as 20 psi with the same pressure at the tuyere openings to support the metal. Any substantial reduction in the pressure will make lower costs per ton for blown metal.

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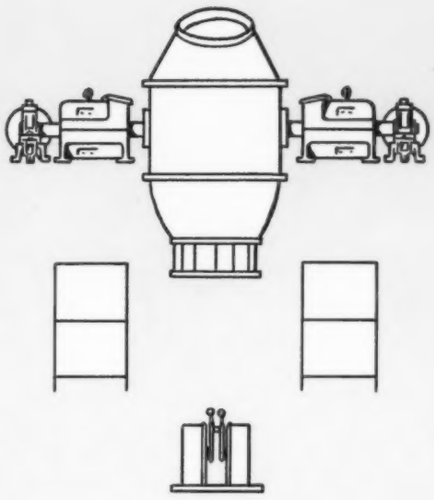

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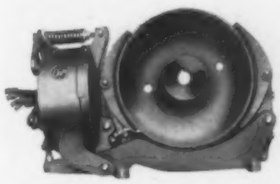

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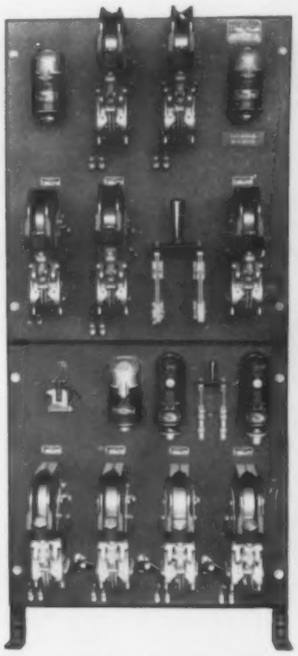

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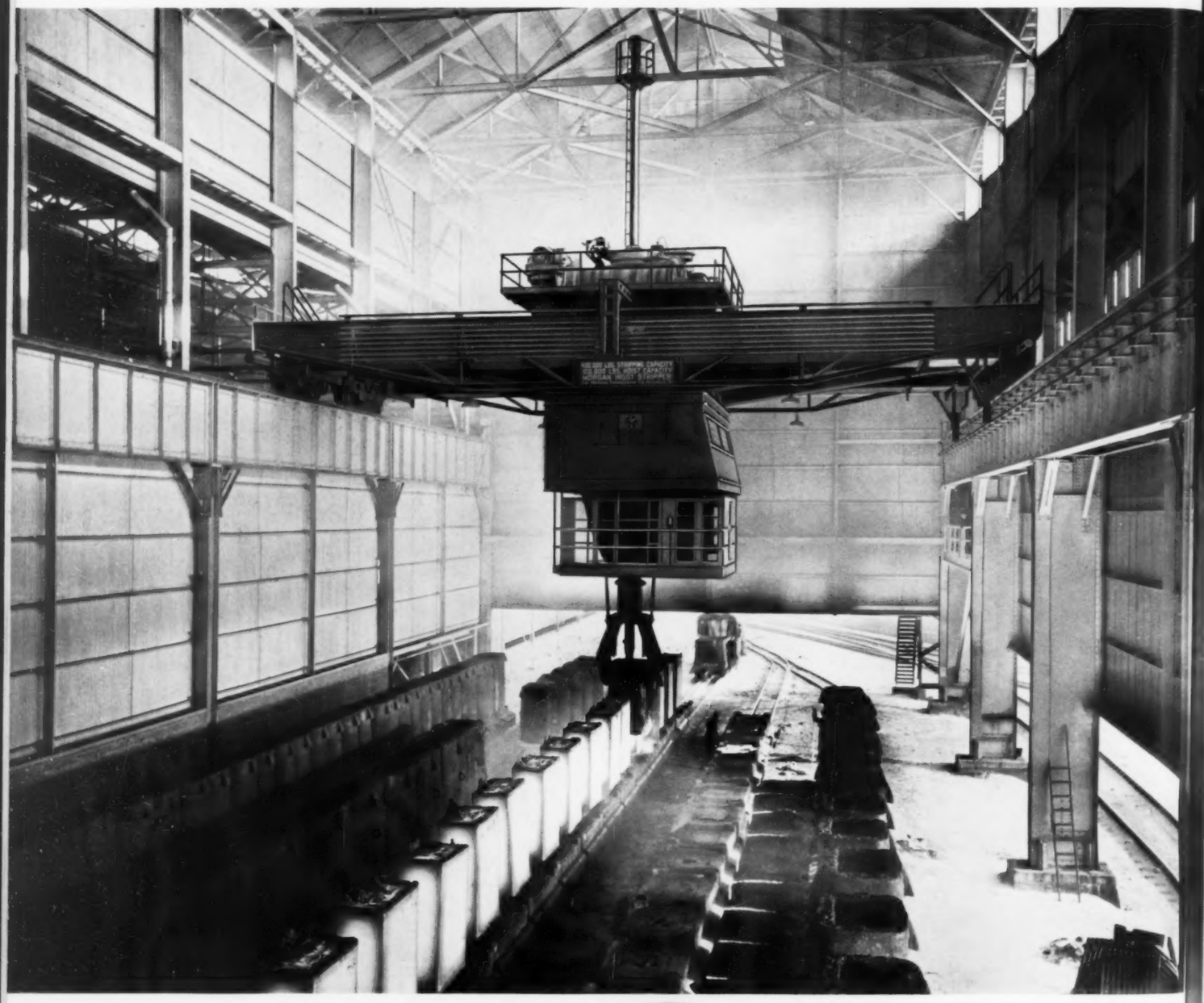

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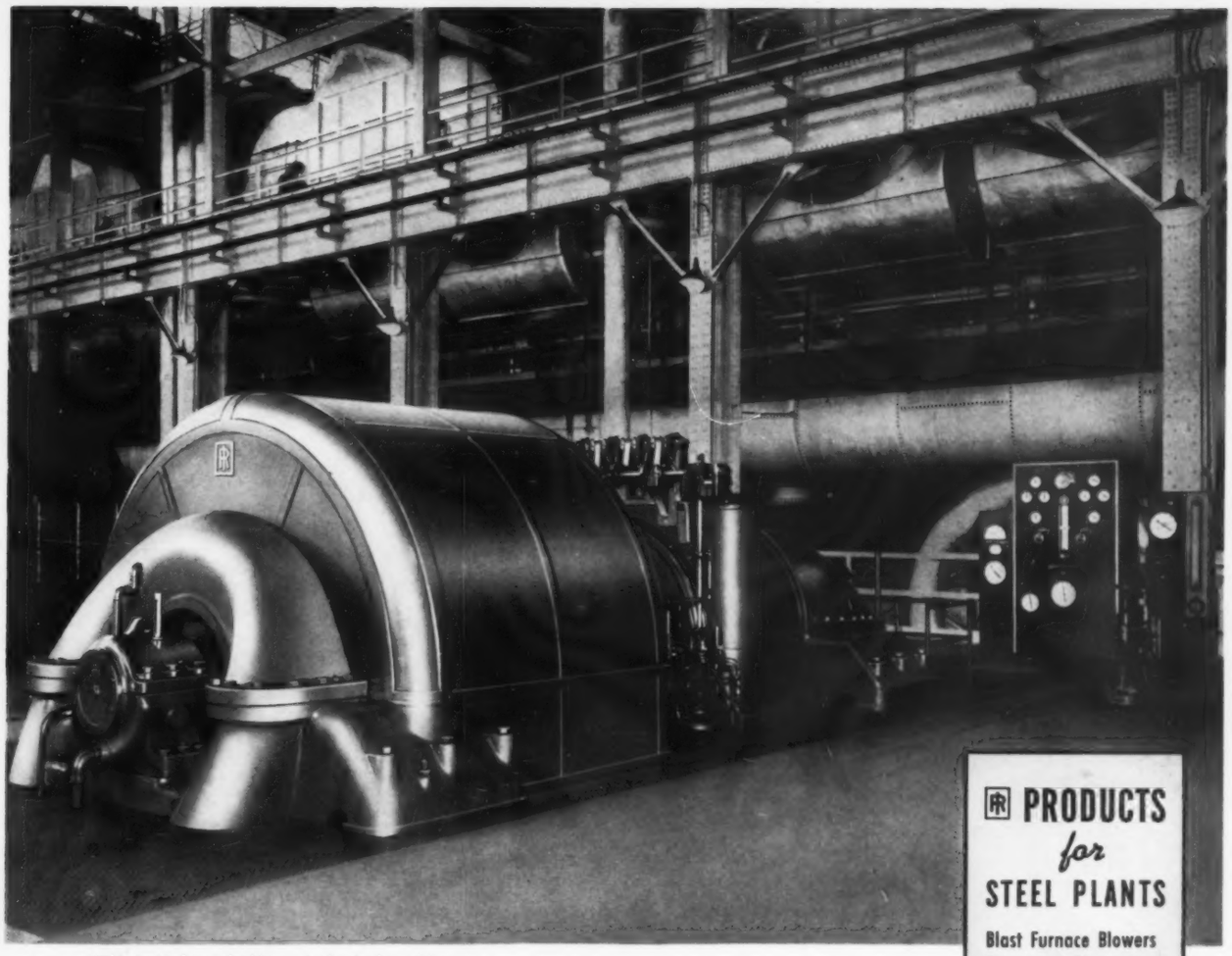

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San Francisco
Scranton
Seattle
St. Louis
Tulsa
Washington

No single machine can be pointed out as typical of the I-R line of turbo-blowers, for the line includes both single- and multi-stage units covering a tremendous range of capacities. For example, a 14,500-hp blast furnace blower, of the type shown above, will deliver 125,000 cfm at 30 pounds pressure, while the smallest 2-hp Ingersoll-Rand Type G Motor-blower has a rating of 500 cfm at 8 ounces pressure.

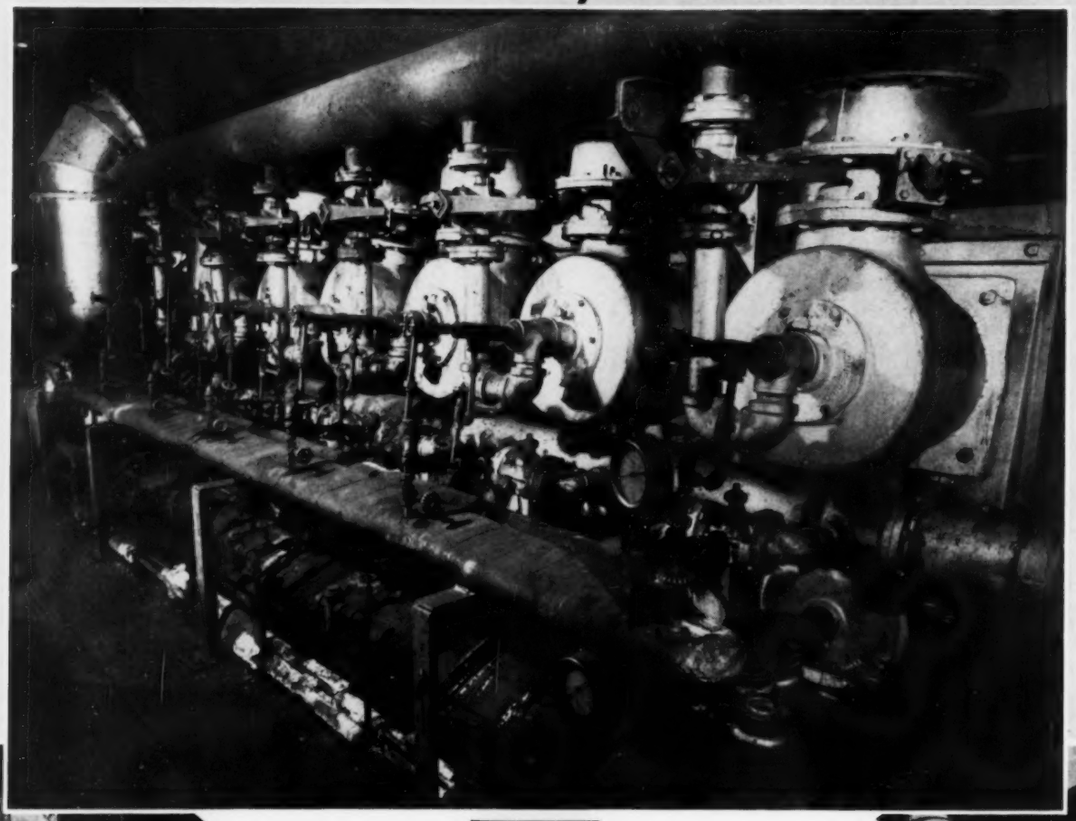
Ingersoll-Rand

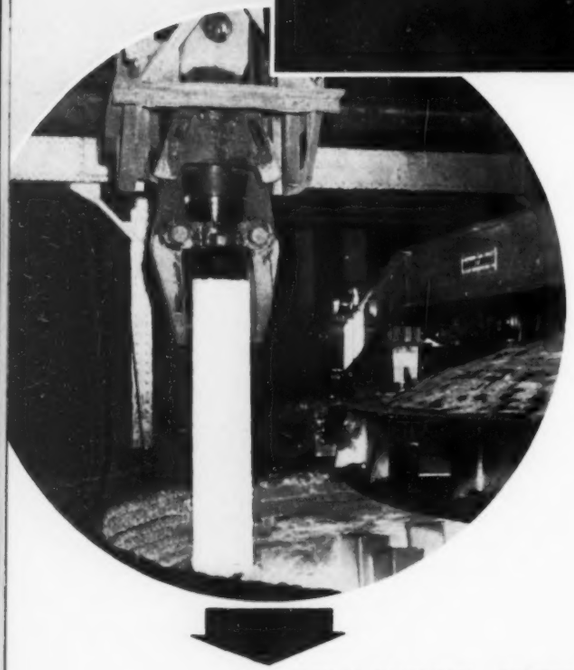
11 BROADWAY, NEW YORK

12-149

QUALITY SPEED ECONOM

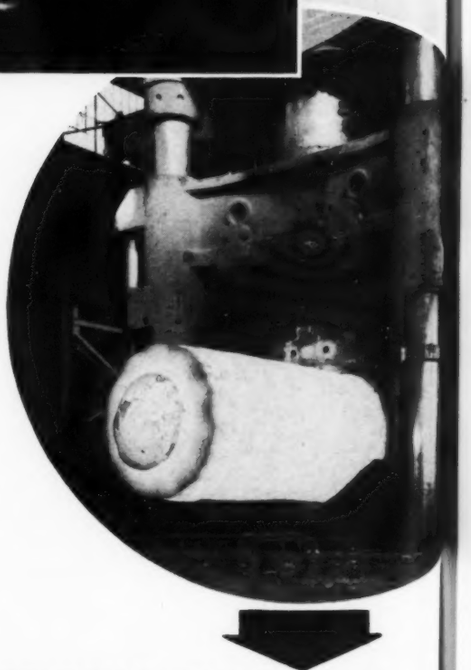
with **BLOOM** *long Flame burners*





IN BILLET HEATING FURNACES

With preheated or cold air. Top and bottom fired furnaces heating 185 lb. per sq. ft. per hr. Single zone fired furnaces heating 140 lb. per sq. ft. per hr.



IN SOAKING PITS

Burners now operating on every type of direct-fired or recuperative soaking pit. Cold steel heated with 1,200,000 Btu per net ton.

IN FORGING FURNACES

Quality heating of gun forgings shells, bombs, etc. From 100 in diameter ingots down to 3 in. shell stock.

BLOOM ENGINEERING CO

916 Behan St. · Pittsburgh, Penna

REPRESENTATIVE W. T. DEAN · · · 452 GRANT ST., GARY, INDIA

Steel, mainly of killed grades, .04-.95 per cent carbon, is poured into 4000 lb big-end-down ingots.

ATLANTIC STEEL COMPANY

By T. J. Ess with personnel photographs by J. R. Scott

▲ LOCATED about three miles from the center of Atlanta, Georgia, and lying partially within the city limits, the Atlantic Steel Company forms an important link in the growing chain of industrial activity in the southeastern section of the United States.

Aside from the excellent reputation enjoyed by its products, the company is noted for two things more or less extraneous to the production of steel. Perhaps no other plant has served as a training ground for so many men who have reached high places in the steel business —an incidental but none the less valuable contribution to the industry. The second item is the extensive program of plant beautification. Scattered throughout the plant are many small garden spots, flowers and shrubs, making the plant a veritable show place and striking an unusual note of contrast in the midst of steel plant activities.

Founded in 1901 as the Atlanta Steel Hoop Company, the original plant consisted mainly of rolling equipment. In 1906, the name was changed to the Atlanta Steel Company, and the open hearth, blooming mill, rod and wire mills were installed. In 1916, it was changed to Atlantic Steel Company. Then followed a gradual expansion of rolling facilities and an electrification program, resulting in the compact, efficient plant of the present, with an annual basic production capacity of 157,000 net tons of ingots. A typical distribution of this steel to the different mills shows 73,000 net tons on the rod mill (including wire rods, merchant bars, and deformed bars), 18,000 net tons on the 8 in. hoop mill, (cotton ties and bands), and 31,000 net tons to the 10 in. hoop mill (consisting of small shapes, hoop steel and merchant bars).

OPEN HEARTH

The open hearth shop contains three furnaces, 55 ft 8 in. overall length and measuring 34 ft 8 in. in length, knuckle to knuckle. Bath dimensions are approximately 31 ft x 13 ft 6 in., with a maximum depth of 22 in. The furnaces are well insulated from the skewbacks down to the ground, and are fired with natural gas introduced through ports in the side walls of the furnace between the knuckle and the downtake. As an auxiliary fuel, for periods of gas shortage, oil may be used, being fired through retractible, steam-atomizing burners in the end walls.

Two of these furnaces were originally built for producer gas fuel, with double regenerator chambers, 5 ft 9 in. and 8 ft 0 in. wide by 27 ft 11 in. long. In changing over to natural gas, the regenerators were modified into a two-pass design, with checkerwork in each pass about 7 ft deep. The third furnace was originally designed to use powdered coal, but has also been modified for natural gas firing. All of the furnaces use a single downtake and are equipped with water-cooled slide damper reversing valves. Automatic furnace pressure control is provided on each furnace, and furnace reversal times are signaled by checker temperature measurement. Fuel consumption averages about 4,500 cu ft of natural gas per ton on ingots. Furnace charges average 153,000 lb, composed of approximately 30 per cent pig iron and 70 per cent scrap. Coke is charged as a carburizer, and about 7,500 lb of burnt lime serves as flux. Heats of approximately 70 tons are tapped with a heat time, charge to tap, of 10½ hr. Steel is poured into 4,000 lb big-end-down ingots, 14¾ in. x 14¾ in. on the bottom. No hot tops are used. Moulds are given an internal graphite spray before teeming. The product consists mainly of killed steels, ranging .04-.95 per cent carbon. Some screw stock and copper bearing steels are made.

The open hearth shop is served by one 100-ton ladle crane, one 60-ton crane, and one 10-ton crane on the pit side, and one 5-ton, high-type changing machine on the charging side. Charging buggies are brought from the stock yard to the open hearth by a diesel-electric

locomotive, and are taken up a short, sharp incline from yard level to charging floor level by an endless inclined chain lift.

BLOOMING AND BILLET MILLS

Ingots are stripped in the open hearth building and conveyed by an ingot transfer table to the soaking pits. There are five pits, of the circular, one-way fired design. These pits are 16 ft in diameter at the top and 20 ft 9 in. in diameter at the bottom. Twelve combination gas-and-oil burners are placed around the circumference of the pit near the bottom, firing through 15 in. circular ports at an angle of about 37 degrees with the radius. A bridge wall, 15 in. high, is located 18 in. in front of the burner ports. The pits are 7 ft 10 in. deep above a 12 in. coke bed. Waste gases leave the pit through a single center off-take 7 ft 4 in. in diameter. A common manifold flue serves the five pits, and is connected to two stacks which formerly served the old pits. Pit covers are moved by a special traveling mechanism, and a 5-ton stiff-leg crane handles ingots to and from the pits.

Automatic controls are applied to pit pressure, fuel-air ratio, and temperature. Natural gas is the preferred fuel, although oil is available as a stand-by in case of a shortage of the former. Fuel consumption averages about 2,100 cu ft of natural gas per ton, the ingots being rather cold when charged.

As an ingot is drawn from a pit, it is placed on a transfer buggy and carried to the blooming mill approach table.

The bloomer is a 25 in. two-high reversing unit, driven by a 600 volt, 0-150 rpm, d-c reversing motor rated at 2,200 hp average load, 5,000 hp peak load. This motor receives power from a flywheel set consisting of one 1,800 kw, 600 volt d-c generator and one 1,600 hp, 2,200 volt, 514 rpm induction motor, controlled through a slip regulator. The flywheel on this set is 12 ft in diameter and weighs 60,000 lb. The blooming mill reduces ingots down to 4 in. x 4 in. blooms, which then proceed to a 14 in. billet mill 100 ft distant. Located 59 in. ahead of the first stand of the billet mill is a crop shear which is driven through a clutch from the main line shaft of the billet mill drive.

The billet mill is a continuous mill of six stands placed on 9 ft centers, all driven through a line shaft and gears by one 1,600 hp, 2,200 volt, 257 rpm induction motor. Gearing is arranged so that speeds are 16.6, 22.4, 30.3, 40.0, 52.2, and 70.0 rpm for the respective stands, with a final delivery speed of 252 fpm. When rolling flats, the sixth stand is not used, and the delivery speed is 195 fpm. Two edgers placed between the second and third stands and between the fourth and fifth stands, and driven by a 75 hp motor and a 100 hp motor, respectively, are used only when rolling flats.

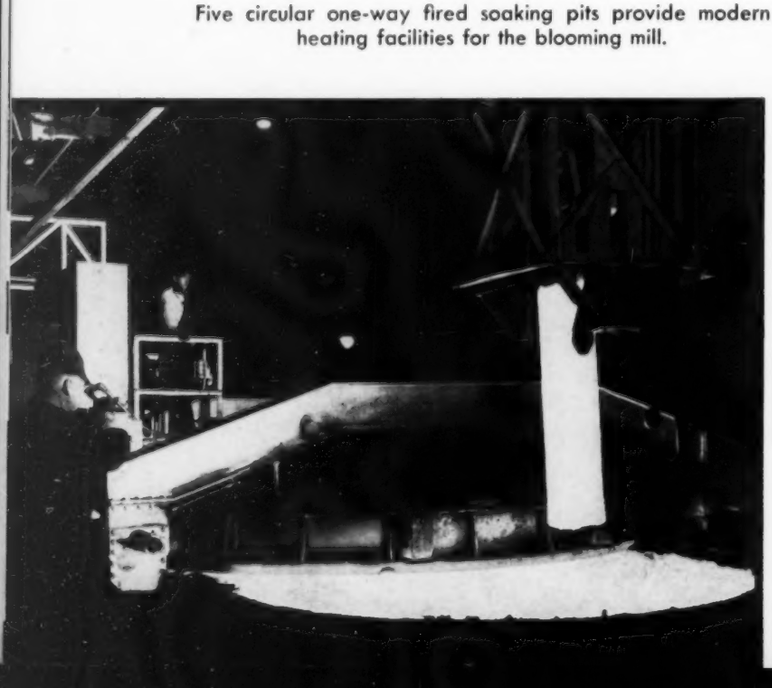
Taking 4 in. x 4 in. stock from the bloomer, the billet mill produces a wide range of sizes: billets, 1½ in. x 1½ in. to 2¾ in. x 2¾ in.; slabs, 2¼ in. x 2¾ in., 2⅝ in. x 3 in., and 2¼ in. x 3⅝ in.; flats, ¼ in.—2 in. thick and 4 in.—10 in. wide. The product from this mill is preponderantly billets for further processing, although

N. C. HARRISON

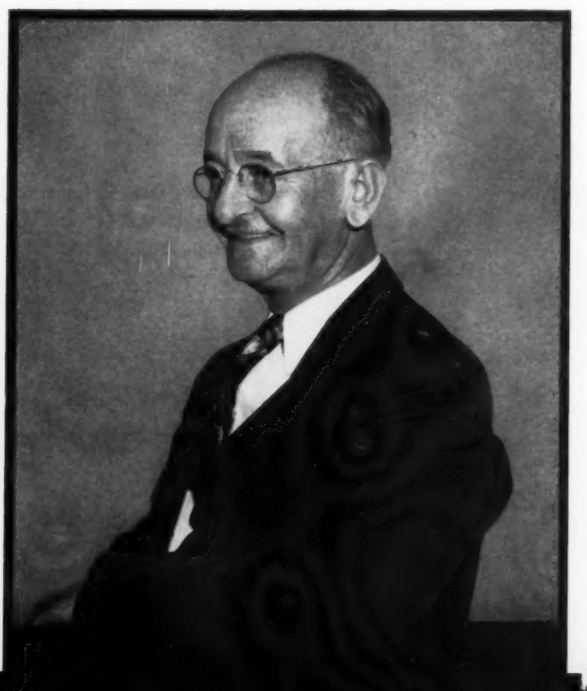
VICE-PRESIDENT AND GENERAL SUPERINTENDENT

G. D. WALTERS

SUPERINTENDENT, OPEN HEARTH AND BLOOMING MILL



Five circular one-way fired soaking pits provide modern heating facilities for the blooming mill.



R. H. LOWNDES

CHIEF ENGINEER

R. E. BOBBITT

MECHANICAL AND ELECTRICAL SUPERINTENDENT

about 11,000 tons of bar material are turned out annually.

A steam-driven flying shear is placed 20 ft from the last finishing stand, and the mill table proceeds on to two 30 ft racking-type cooling beds. The mill runout table is driven through a line shaft geared back to the main mill drive motor.

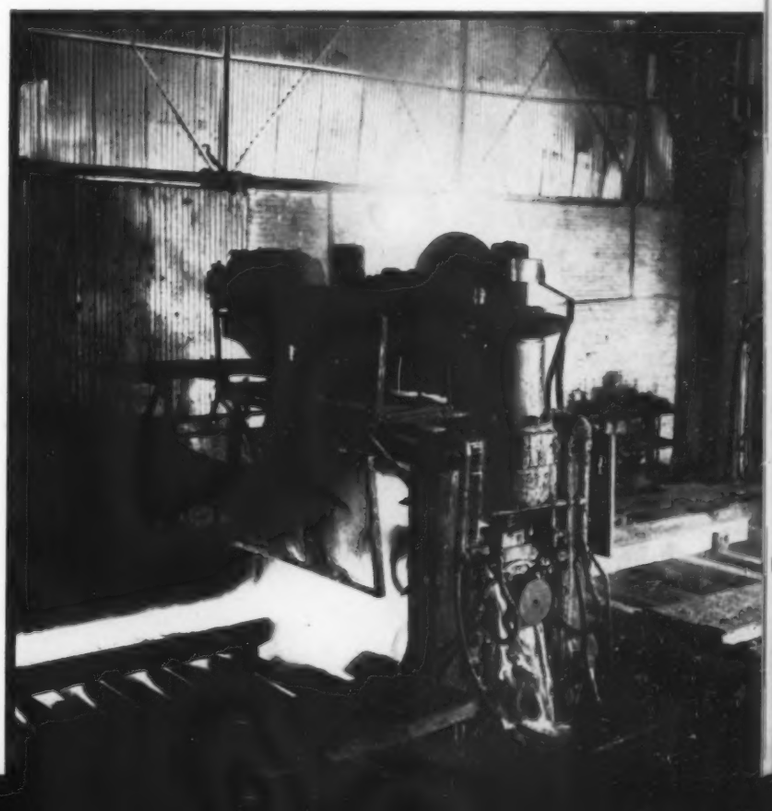
A billet yard, 70 ft wide and served by a 10-ton crane, runs across the end of the billet mill building and extends on across the end of the nearby rod mill building.

ROD AND BAR MILLS

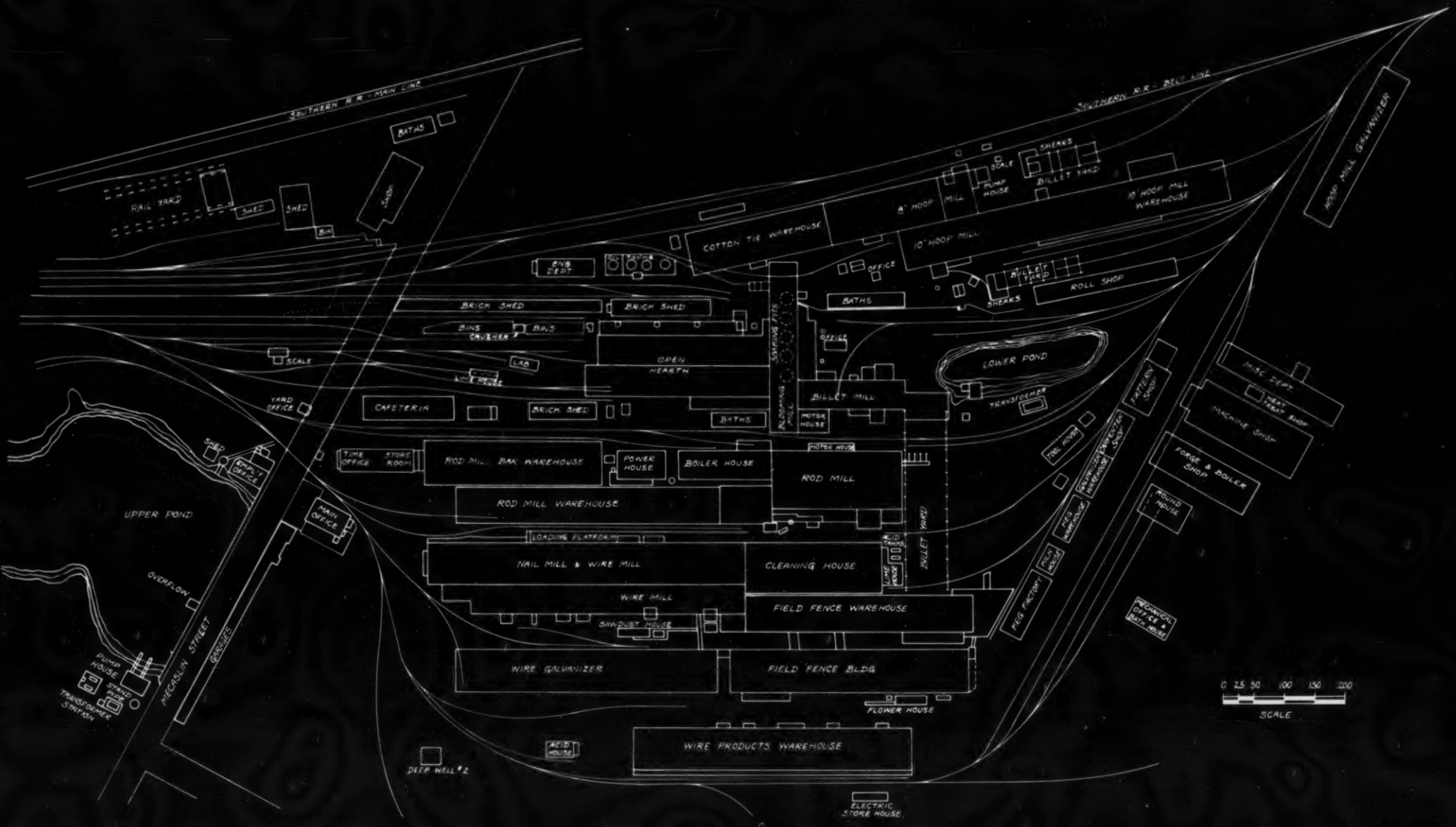
The rod mill is a 12-10-8 in. unit of typical design. Six two-high stands, on spacings of about 40-48 in., form a continuous roughing line. The rolls in the first two stands are approximately 12 in. x 15 in., and in the remaining four stands, 10 in. x 15 in. The six stands are driven through a speed reducer and a spur gear train by a single 975 hp, 600 volt, 250-650 rpm d-c motor, giving maximum roll speeds of 23.8, 34.8, 69.6, 103, 144, and 194 rpm. Following the roughers are five intermediate stands, arranged as shown in the accompanying sketch and driven through belts by one 1,840 hp, 600 volt, 220-575 rpm d-c motor. Of these stands, the first two employ rolls 10½ in. x 24 in. and run at a maximum speed of 304 rpm. The next two stands, using 8 in. x 16½ in. rolls, run at a top speed of 495 rpm, while the fifth stand, also with 8 in. x 16½ in. rolls, runs at 674 rpm, maximum. A three-stand finishing line, on 36 in. centers, with rolls 8 in. x 16½ in., completes the mill, and is driven through belting by a 975 hp, 600 volt, 450-865 rpm d-c motor. The three main drive motors operate under variable voltage and field control, receiving power from a dual motor-generator unit consisting of two 1,280 kw, 600 volt d-c generators driven by a 3,720 hp, 2,200 volt, 720 rpm synchronous motor.

When rolling No. 5 rod, a delivery speed of 2,205 fpm is attained from No. 14 stand, and the material passes on to four reels driven by a single 20 hp, 400-1,600 rpm d-c motor. When rolling flats or bars, the stock is delivered from No. 12 stand at a speed of about 756 fpm on to a double hot bed 240 ft long, actuated by a

Ingots, 14¾ in. x 14¾ in., are reduced to 4 in. x 4 in. blooms in this 25 in. two-high reversing blooming mill.



PLAN VIEW—ATLANTIC STEEL COMPANY
ATLANTA, GEORGIA



W. R. POTTS

ASSISTANT SUPERINTENDENT, MECHANICAL AND ELECTRICAL DEPARTMENTS

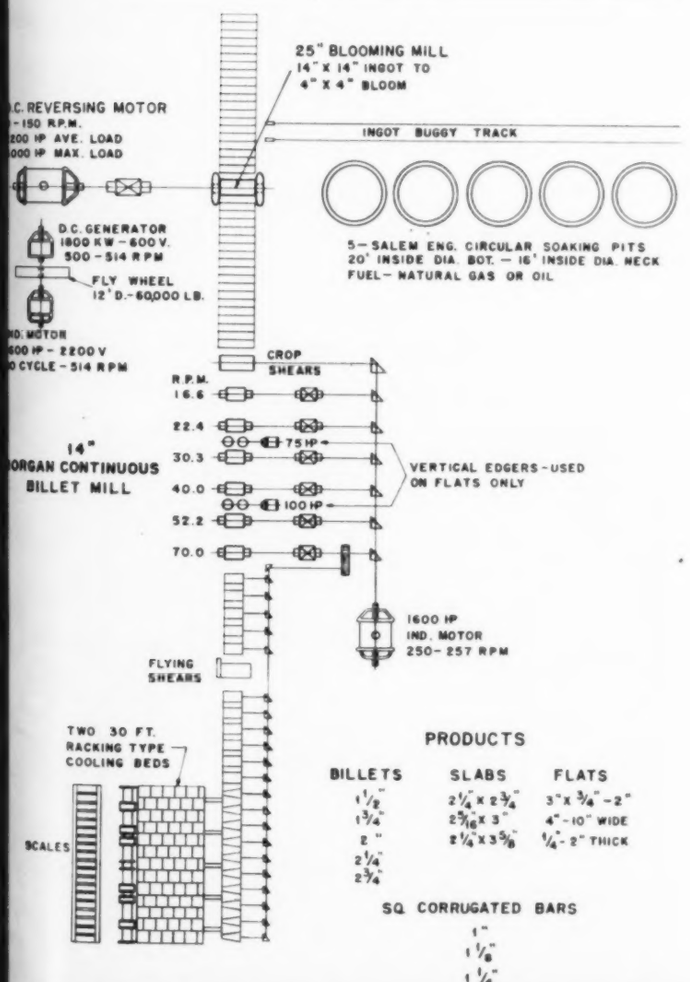
steam racking unit. A shear is provided in each hot bed runout.

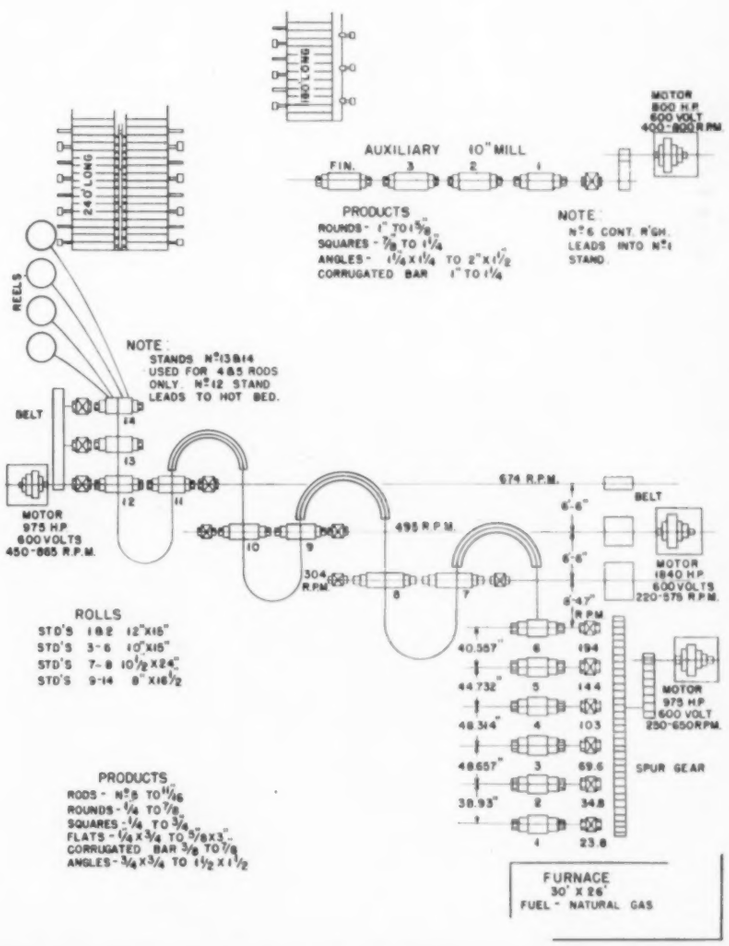
The rod mill produces rods up to $^{11}/_{16}$ in.; rounds, $^{1}/_{4}$-$^{7}/_{8}$ in.; squares, $^{1}/_{4}$-$^{3}/_{4}$ in.; flats from $^{1}/_{4}$ in. x $^{3}/_{4}$ in. to $^{5}/_{8}$ in. x 3 in.; corrugated bar, $^{3}/_{8}$-$^{7}/_{8}$ in.; and angles, $^{3}/_{4}$-1$^{1}/_{2}$ in.

An auxiliary 10 in. mill has been installed, consisting of three three-high and one two-high stands, all driven by a single 800 hp, 600 volt, 400-800 rpm d-c motor. The motor receives power from a 650 kw, 600 volt, d-c generator driven at 720 rpm by a 950 hp, 2,200 volt synchronous motor. This mill is fed from the roughing train of the rod mill, and produces 1-1$^{5}/_{8}$ in. rounds, $^{7}/_{8}$-1$^{1}/_{4}$ in. squares, 1$^{1}/_{4}$-2 in. angles, and 1-1$^{1}/_{4}$ in. corrugated bars. From the finishing stand, operating at a speed of about 850 fpm, material passes to a cooling bed 180 ft long. The runout line of the cooling bed is composed of rollers individually driven by variable frequency motors.

Billets supplied to the rod mill, consisting of 1$^{1}/_{2}$-2$^{3}/_{4}$

Below left—Layout of blooming and billet mills. Below right—Layout of 12-10-8 in. merchant mill.





D. A. LENNOX

ROLL DESIGNER

in. squares or slabs 2¼ in. thick x 2¾-3⅝ in. wide, are heated in one continuous side-charge, side-discharge furnace, 29 ft 9 in. long x 32 ft 4 in. wide. The furnace roof is of rather unusual design, consisting of a series of arches sprung from bottle-shaped bricks suspended from the furnace steel work. The furnace burns natural gas through fifteen low-pressure proportioning burners, and an average fuel rate of about 2,000 cu ft of gas per ton of steel is obtained. Air for combustion is preheated to about 600 F in a sheet-pack regenerative type heater.

The re-rolling of old rails is also carried out on the rod and bar mills, amounting to 6,000-7,000 tons per year. When performing this operation, the first two stands of the roughing line are eliminated, and the heated rail is slit into its three component sections—head, web, and flange—as it passes through the remaining roughing stands. The head and web are then rolled simultaneously through the rod mill, while the flange proceeds through the auxiliary bar mill. The head may be converted into small rounds, squares, or angles, and the web into bands or very small rounds, squares, angles, while the flange is usually converted into angles.

HOOP MILLS

Two hoop mills complete the rolling facilities of the plant. The first of these is an 8 in. unit, composed of three three-high and two two-high stands, placed side by side in a typical looping layout. The first four 2tands are driven directly by a 500 hp, 260-325 rpm, s30 volt d-c motor. The finishing stand is driven by a 225 hp, 400-500 rpm, 230 volt d-c motor. Both of these motors draw power from the general d-c system in the plant and are operated under field control. Repeaters connect all passes in the first three stands. At speeds of 1,400-2,000 fpm, material is delivered from the mill onto a double hot bed 217 ft long. Mill products include cotton ties, hoop, and bands ranging ½-1¼ in. wide and No. 20 gauge to 3/16 in. thick, and small ovals, half ovals, etc.

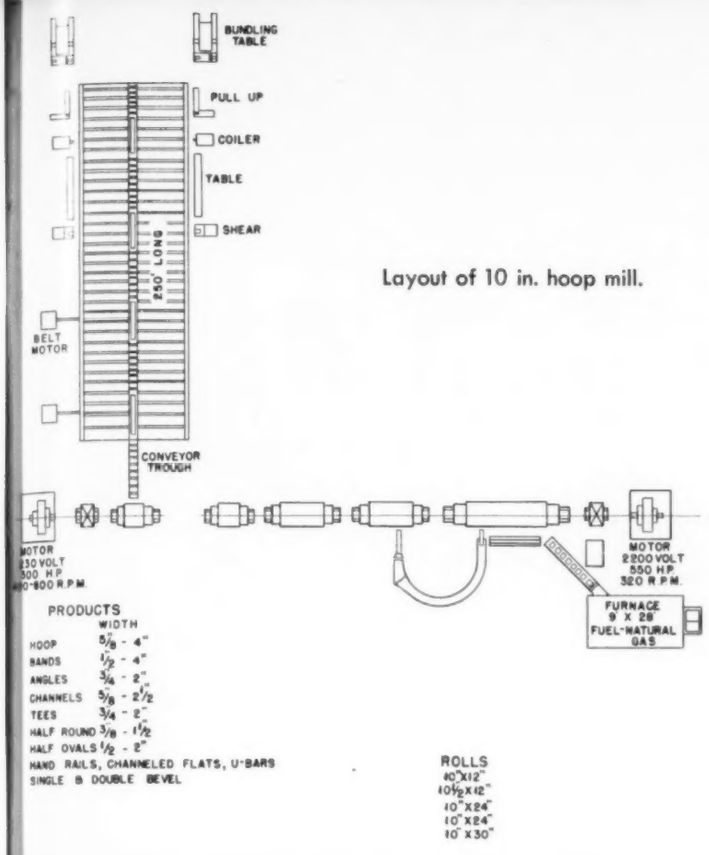
Billets fed to the mill are 1½ in. square, and are heated in a continuous furnace, end-charge, side-discharge, 28 ft long x 9 ft wide. Furnace walls are 13½ in. thick, plus 4 in. of insulation, and are steel cased. The roof, of sprung arch construction, consists of 9 in. of firebrick and 4 in. of insulation. Six water-cooled skid pipes carry the billets for more than half

R. W. SANDELIN

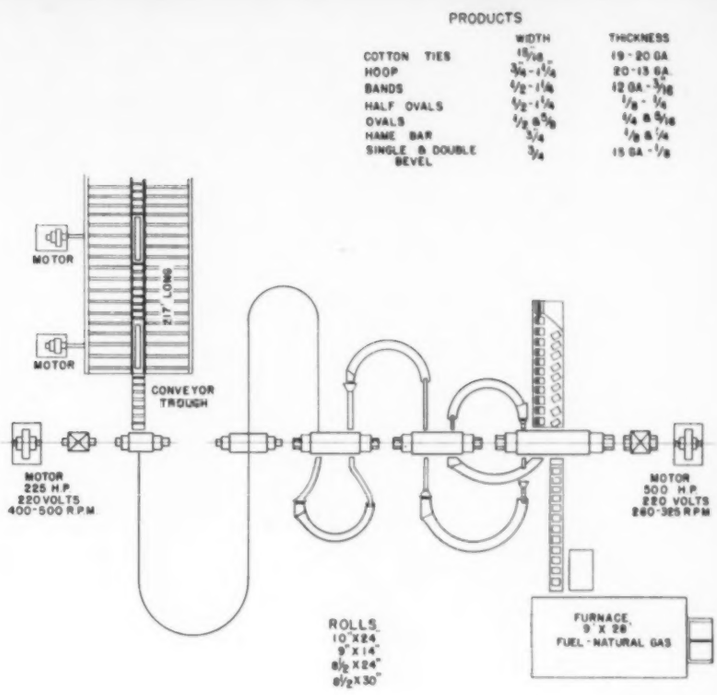
CHIEF METALLURGIST

E. E. SCHUKRAFT

SUPERINTENDENT OF HOOP MILLS



Layout of 10 in. hoop mill.



Layout of 8 in. hoop mill.

of the hearth length, after which a solid refractory hearth is used. Natural gas is introduced through three low-pressure proportioning burners, and fuel rates average 2,400-2,700 cu ft of gas per ton.

The second hoop mill is a 10 in. unit, similar in design to the 8 in. mill. The heating furnaces are practically identical. A 550 hp, 320 rpm, 2,200 volt induction motor and a 190 hp, 206-320 rpm, 412 volt d-c motor, mounted on the same shaft, drive the first four stands with a Kramer system of control, using a 145 kw, 630 rpm, 0-412 volt rotary convertor. The finishing stand is driven by a 500 hp, 400-600 rpm, 230 volt d-c motor.

A repeater connects the first and second stands of the mill. Delivery speeds are 1,200-1,500 fpm, and the hot bed is 250 ft long. The mill takes square billets 1½-2¼ in., or slabs 2¼ in. thick x 2¾-3⅝ in. wide, reducing them to hoop or bands ½-4 in. wide, to small angles, channels, and tees, 2½ in. or smaller, or to half rounds, half ovals, etc.

A continuous pickling and galvanizing unit for strip, and a job galvanizer for bars and shapes provide facilities for coating such products from the rolling mills as may be desired.

WIRE MILL

As previously mentioned, rod production runs about 33,600 net tons per year, the major portion of which is drawn into bright wire. Equipment for drawing this wire includes two five-block continuous machines, two four-block continuous machines, four double-deck blocks, three bull blocks, ten four-block machines, six five-block machines, and two twelve-block benches, in addition to one two-block and one five-block machine for redrawing. Product includes all sizes of wire from ⅝ in. down to No. 20 gauge.

Prior to drawing, the coils from the rod mill are cleaned in a batch pickler composed of three steel tanks, lined with rubber. Each tank holds four stems of wire and the coils are handled by a two-ton, stiff leg, wire handling crane. Pickling ordinarily requires 15-20 min in a solution of 5 per cent sulphuric acid maintained at about 180 F.

After thorough rinsing, the coils are given a lime coating by dipping in either of two tanks containing a solution of milk of lime about 140 F. The coils next proceed to two gas-fired bakers, each containing three alleys and holding fifteen trucks of wire. The bakers are fired with natural gas in a circulating convection system, and the coils remain in the baker for 1-6 hrs according to product at temperatures ranging 250-400 F, thoroughly drying the lime coating and driving off hydrogen absorbed in the pickling process, eliminating any tendency toward acid brittleness. Wire is then drawn as soon as its temperature has dropped to room level.

The redrawing machines previously mentioned are used principally for the production of coated wire by the wet drawing process, using solutions prepared according to the type of coating desired. A wide range of types of welding rod is produced.

Additional fabricating and finishing equipment includes 109 nail machines (for nails ranging from ½ in. x No. 20 gauge to 12 in. x ⅜ in.), two staple machines, ten rivet machines (for rivets from 6 oz per M to 4 in. x ⅝ in.), eight fence machines (for fence 26-72 in. wide, of No. 9-18 gauge wire), twelve barb wire machines, ten bale tie machines. There are further provided one nail galvanizing unit, one nail bluer, one continuous

C. L. McGOWAN

SUPERINTENDENT OF WIRE DEPARTMENTS

32-strand wire galvanizer, one nail electroplating unit (for copper, cadmium, or zinc plating), one rivet tinning machine and eight wire straightening and cutting units.

Three gas-fired annealing pots are provided for the production of annealed wire and bale ties, and for annealing rivets.

The wire-product warehouse is equipped with an automatically controlled heating system designed to so regulate temperature and humidity as to adequately protect the surface of the stored product.

The wire mills use 30,000 to 35,000 net tons of rods per year. These are drawn into bright wire, and made into the following: Nails, galvanized nails, cement coated nails, galvanized wire, barbed wire, woven fence, annealed wire, bale ties, rivets, etc.

A miscellaneous shop, well supplied with punch presses, drill presses, threading machines, welding equipment, etc., fabricates a wide variety of specialties, including washers, fence posts, gates, wagon hardware, and many other items.

PLANT SERVICES

As may be noted in the foregoing, natural gas forms the principal fuel for the entire plant, being piped from the gas fields of Louisiana and supplied to the plant at a pressure of about 37 psi. Fuel oil, used as an auxiliary, is received in tank cars. Four 50,000 gal tanks provide oil storage.

No electric power is generated in the plant, all power being furnished at 19,000 volts, 60 cycles, by the utility company serving the district. Incoming power is stepped down to 2,300 volts in several main transformer stations, totaling 10,100 kva. The plant sets 15 min demands as high as 8,800 kw. Direct current is provided at 240 volts by three motor-generator sets (of 1,500, 750, and 500 kw capacity, respectively) located in the main power station. Here is also located a steam-driven, d-c generator of 300 kw capacity for emergency use.

Steam is provided from two boilers, of 412 and 375 hp rating, fired with natural gas. Steam is generated at 155 psi pressure, and used for heating, atomizing fuel oil, heating pickling baths, and operating flying shears, furnace pushers, cooling bed racks, etc. One boiler unit is equipped with automatic combustion, feed water, and pressure controls.

Service water for the plant is taken from a reservoir supplied by overflow from the city filtration system. Two 7,000 gpm pumps, each driven by a 200 hp motor, put water from the reservoir into the plant system, which is provided with a stand pipe and operates at a 72 ft head, supplying about 8,000,000 gal per day. Water for drinking and for special purposes is supplied from two 12 in. wells about 500 ft deep, each equipped with a deep-well pump, feeding in turn into two 135 lb pressure pumps. A tie line with the city water system is maintained for emergency use and for boiler feed purposes, the latter being treated with sodium hexa-meta-phosphate.

A hydraulic system, operating at 500 psi, is operated by a triplex 9 in. x 16 in. pump, and serves the hydraulic stripper, blooming mill manipulators and sideguards, and a ballast accumulator.

Two air compressors, rated at 1,200 cfm each, supply compressed air for forge shop hammers, and miscellaneous plant uses.

A complete complement of shops, including machine, boiler, welding, forge, pipe, tin, electric and carpenter shops, provides adequate facilities for all maintenance and general construction purposes.

R. M. LANG

SUPERINTENDENT OF ROD AND BAR MILLS

MORE WIRE - FASTER - for VICTORY!

Atlantic Steel Installs 7 more VAUGHN MOTOBLOCS and MOTOBLOX

Joining the VAUGHN equipment already serving Atlantic Steel Company, four No. 13 D. D. Motoblocs, two 4/5-HR Motoblox and one No. 15 S. D. Motobloc are adding new speed, flexibility and dependability to the battle of production. Consult us on YOUR requirements!

THE VAUGHN MACHINERY CO.

CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE
COLD DRAWING EQUIPMENT
. . . Continuous or Single Hole . . .
For the Largest Bars and Tubes . . .
For the Smallest Wire . . . Ferrous,
Non-Ferrous Materials or their Alloys

KEEP THEM RUNNING

DEPENDABLE POWER IS ESSENTIAL IN THE PRESENT EMERGENCY

● Assure yourself of dependable brush performance on your electrical equipment by enlisting the aid of your National Carbon sales representative. He is capable of giving you valuable assistance in the selection and application of brushes on your generators and motors.

As further assurance of maximum reliability and economy of operation, the services of our engineering staff, experienced in the solution of difficult operating problems, are yours at no added cost when you specify . . . .

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MODERN PYRAMIDS
Another NATIONAL Service

If you are not receiving these practical bulletins on brush operation send us your name and address.

• • •

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☆ ☆ ☆ ☆ ☆

Conserve Copper

● Copper is of prime importance in the national war effort. You can help conserve this essential metal by detaching and saving shunts and connections from worn-out brushes. The copper you save in this way can be reused for other important purposes in your own plant or can be turned over to local salvage agencies to be returned to the nation's supply and thus find its way back into some war task.

Join the drive to conserve essential metals today. Start a copper collection box in your plant.

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Unit of Union Carbide and Carbon Corporation

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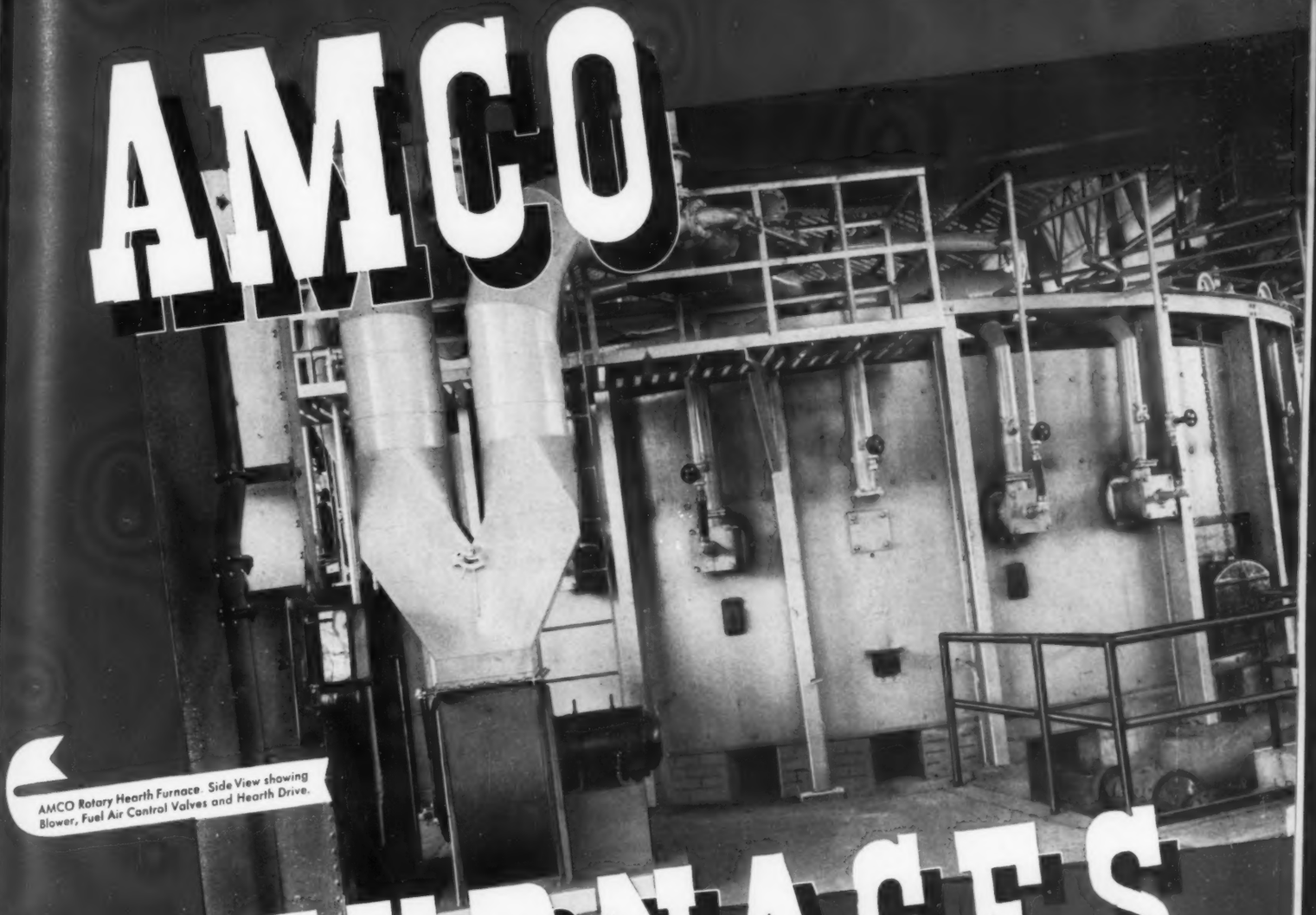
AMCO



AMCO Rotary Hearth Furnace. Side View showing Blower, Fuel Air Control Valves and Hearth Drive.

FURNACES

For Today's Vital Needs

AMCO Heavy Duty Furnace for heating large forgings, ship, railroad equipment.

AMCO Rail Reheating Furnace. Fired with pulverized coal, automatically controlled.

OVER A QUARTER-CENTURY OF ENGINEERING PROGRESS

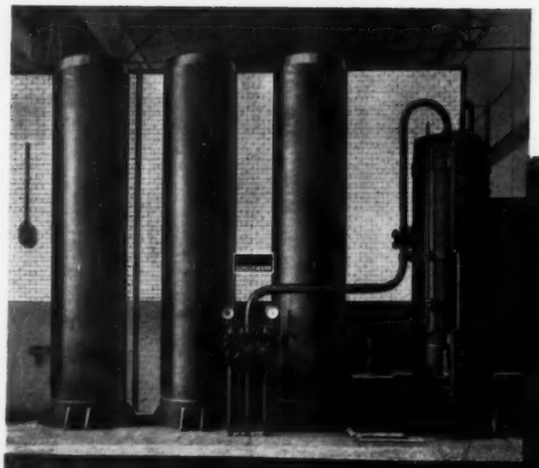
Representing a distinct advance in the technology of the application of heat to metals, AMCO FURNACES successfully and economically meet the varied and pressing demands of today in the vital steel-making industry!

They can be equipped with automatic temperature and pressure controls and can be adapted to the use of all fuels, including *pulverized coal!*

Write for our new Silver Anniversary brochure detailing and picturing AMCO Products

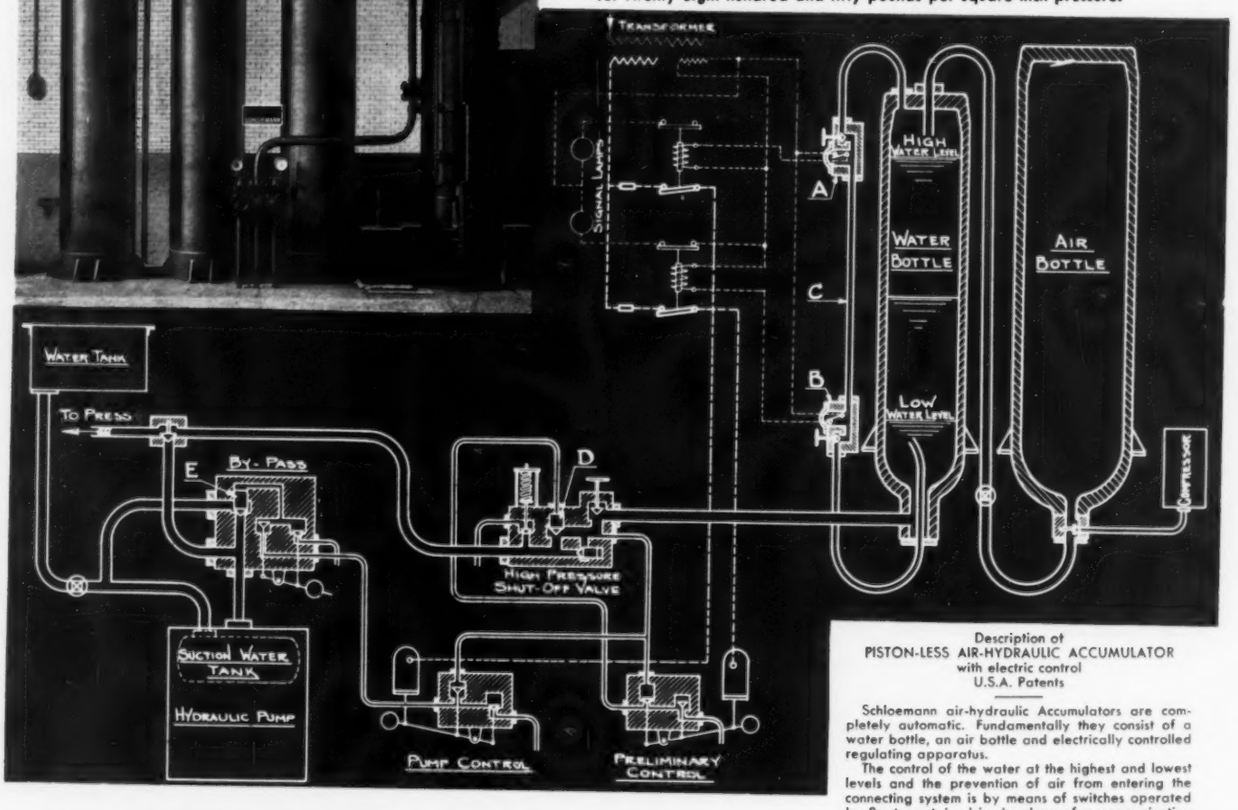
The AMSLER-MORTON Company

FULTON BUILDING · PITTSBURGH, PA.



Accumulators furnished in sizes from fifty gallons to twenty-five hundred gallons and for pressures up to forty-five hundred pounds per square inch.

System shown at left has two hundred gallons capacity and is designed for twenty-eight hundred and fifty pounds per square inch pressure.



Description of
PISTON-LESS AIR-HYDRAULIC ACCUMULATOR
with electric control
U.S.A. Patents

Schloemann air-hydraulic Accumulators are completely automatic. Fundamentally they consist of a water bottle, an air bottle and electrically controlled regulating apparatus.

The control of the water at the highest and lowest levels and the prevention of air from entering the connecting system is by means of switches operated by floats contained in chambers of a communicating tube "C." Thus the switch "A" in the upper chamber controls the operation of the hydraulic pump, while that in the lower chamber "B" controls the check valve "D" which shuts off the accumulator at lower water level.

The continuous running pump is controlled by closing the By-Pass check valve "E" by means of the pump control, causing it to idle by opening the same and returning the water to the suction end. Over-pressure is released through safety valves and is indicated by an alarm.

SCHLOEMANN

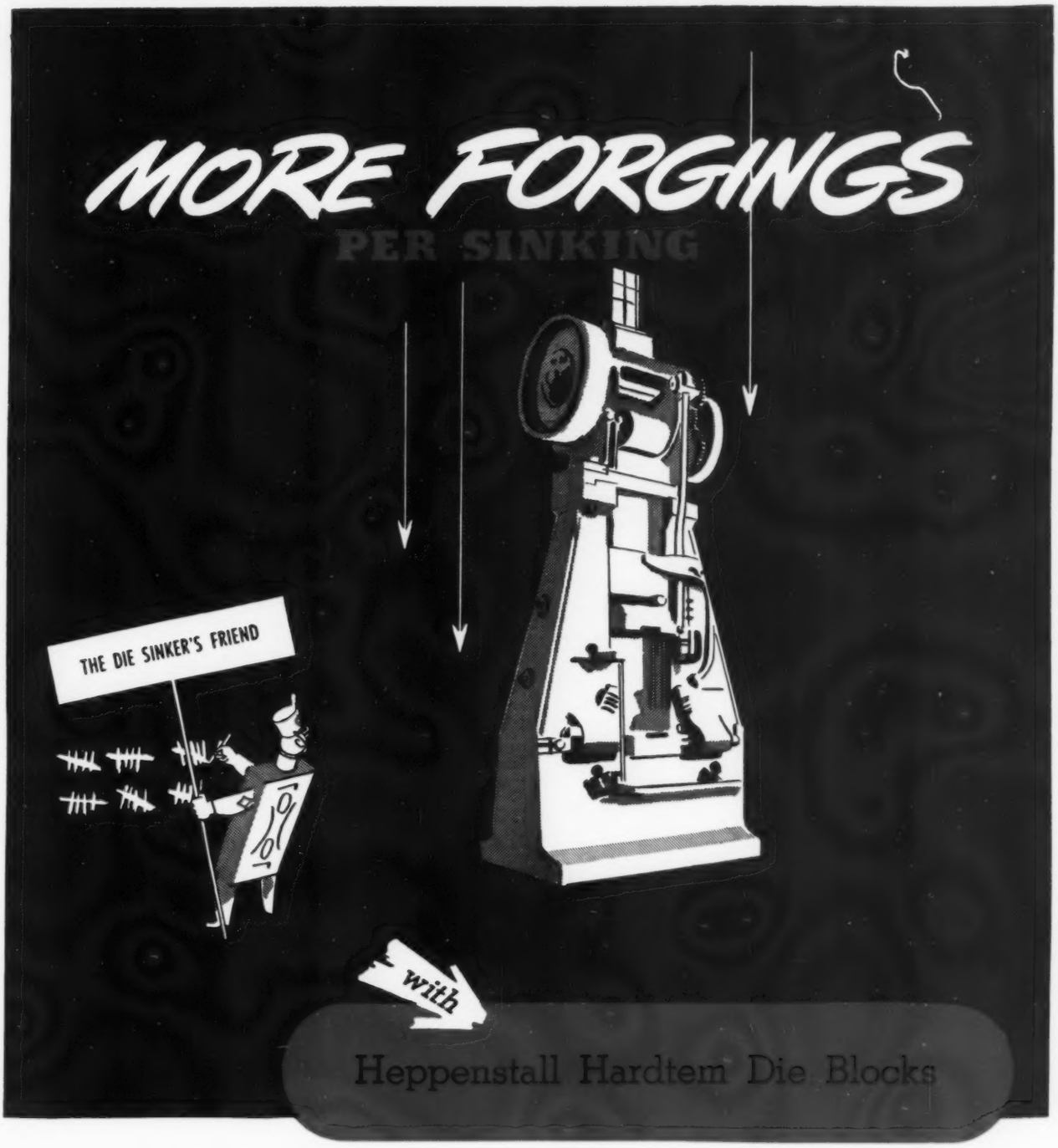
AIR-HYDRAULIC ACCUMULATORS

HYDRAULIC EXTRUSION PRESSES

HIGH PRESSURE PUMPS

COMPLETE HYDRAULIC SYSTEMS

ENGINEERING CORP. PITTSBURGH, PA.
Rolling Mill Machinery Hydraulic Presses



Tough, yet machinable, Heppenstall Hardtem Die Blocks deliver more forgings to the sinking, because they are scientifically forged from Heppenstall's own specially manufactured acid open hearth, alloy die block steel, then heat treated by the exclusive Heppenstall Hardtem process. You'll find they require no further heat treating and impressions can be repeatedly resunk without annealing. • Without obligation, call upon Heppenstall Service Engineers to help you solve die block problems. And next time you order, specify Heppenstall. Use die blocks that last longer and save you time and money. Write for full information, Box E-3, Heppenstall Co., 4620 Hatfield St., Pgh., Pa.

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PITTSBURGH DETROIT BRIDGEPORT

HEPPENSTALL H QUALITY

Forging Fine Steels for More Than Fifty Years

A STRONG FAMILY—

AND THIS MOVING FINGER MECHANISM FITS THEM ALL

These "3C" Bulletin 101 Master Switches are built to stand active service in heavy duty operation.

Roller Bearings on Type RD; Oilite Bearings on Types S2D and Types S4D; accurately molded Impact Bakelite Cams; sturdy steel shafts; Double Break Silver-to-Silver Contacts; and the same Moving Finger Mechanism is interchangeable in all types.

The Contact Bar is easily removed; Pressure Springs will not fly out, being held in place by a large end spring ring, which bears against the cage.

All these features and many more make for low-maintenance on these devices.

Write for fully descriptive "3C" Bulletin 101 Master Switches.

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THE CLARK CONTROLLER CO.

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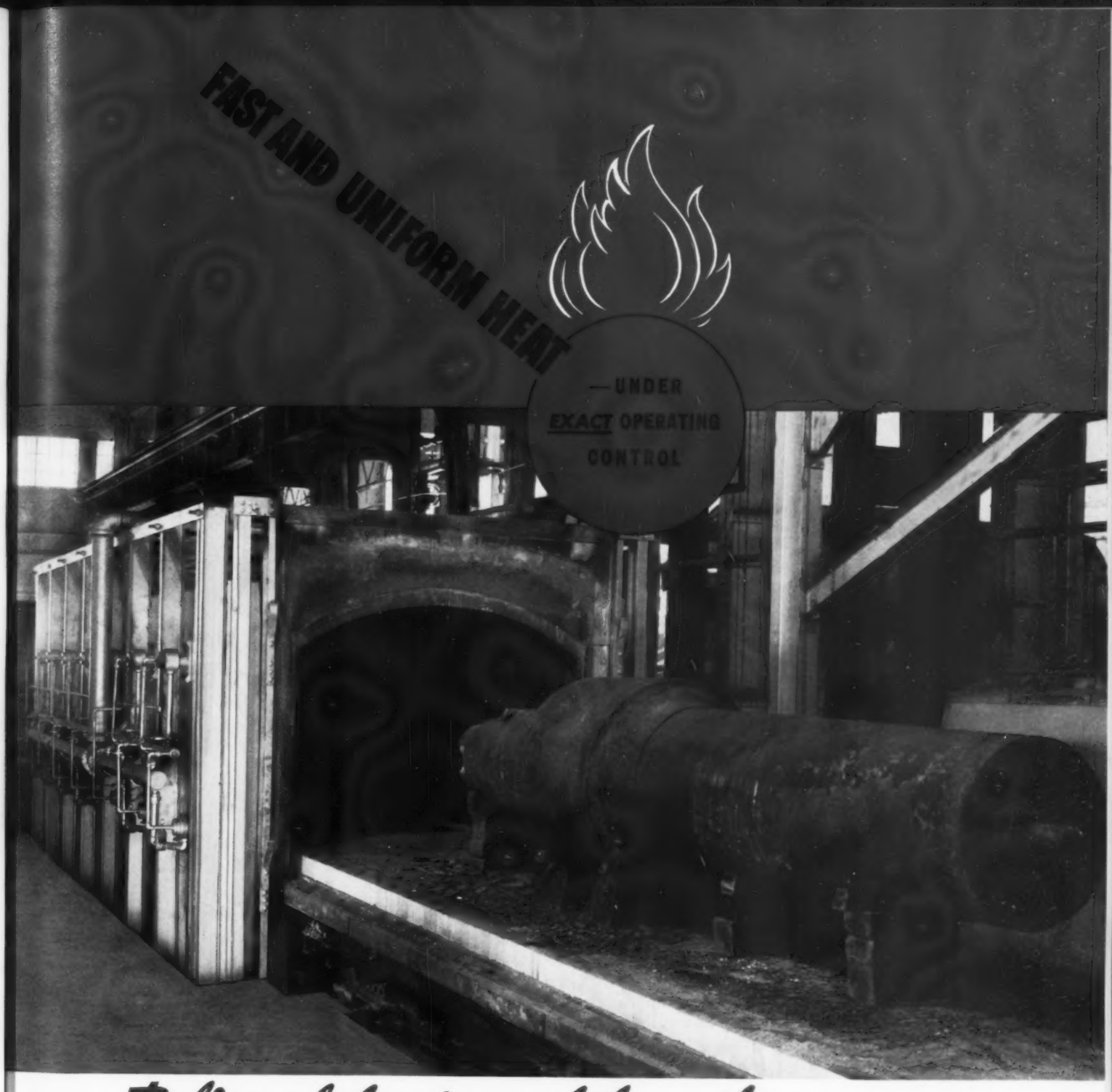

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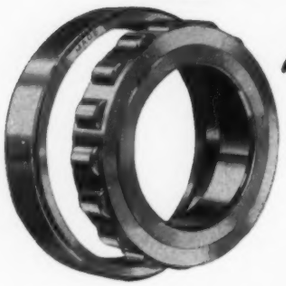
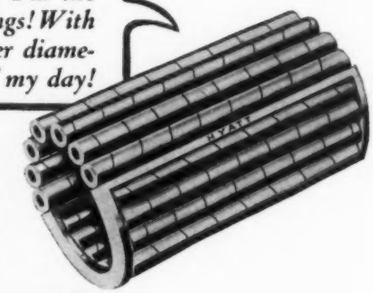
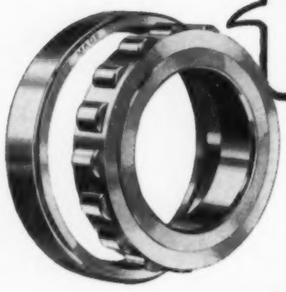
Said 1942 to 1892



1942: *Hi, Old Timer!*

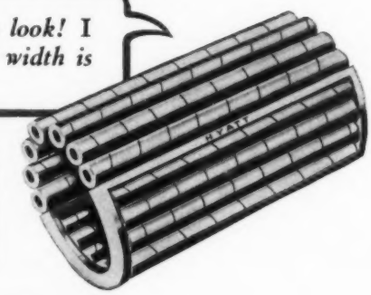
1892: *A little more respect, please. I'm the daddy of our great line of Hyatt Bearings! With a tolerance of .010 in my wound roller diameters I was the Number One bearing of my day!*

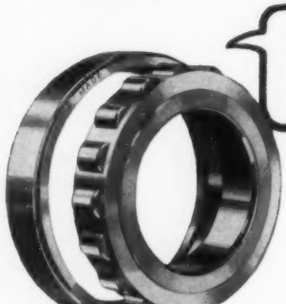




1942: Okay Dad, but with my modern design and close tolerance of one ten-thousandth of an inch, I'm the "fair-haired boy" today.

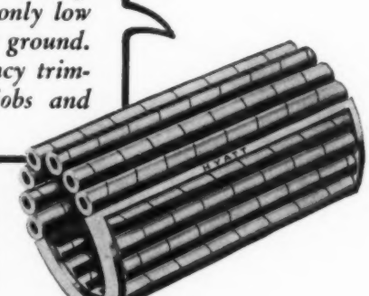
1892: *Hmph! But how skinny you look! I had a width of 6-7 inches while your width is only 1-1½ inches, young fellow.*





1942: *I'm streamlined, old man, but what capacity I possess. And I'm a pretty slick article with my inner and outer race, and my ultra finish.*

1892: *I know . . . I've watched you develop over fifty years. Sure I was made of only low carbon steel and my finish wasn't even ground. In my day, we didn't have all the fancy trimmings—but we handled the tough jobs and handled them well!*



1942: *I appreciate all that, old fellow, but think how out-of-place you would be today with that crude half-spacer roller retainment as compared to my swanky bronze cage and microscopically finished solid rollers and races.*

1892-1942: *You're right, lad. But look me over now. Other than in roller design I've changed considerably during these years. And I'm still in there pitching with you where applications call for my lubrication features and shock load advantages. So—give credit where credit is due!*

THE 50TH YEAR OF

HYATT ROLLER BEARINGS

HYATT BEARINGS DIVISION, GENERAL MOTORS CORPORATION, HARRISON, NEW JERSEY

An Organization of FUEL DEPARTMENT PERSONNEL and Practice

By T. J. McLoughlin

Presented at A. I. S. E. ANNUAL CONVENTION
CLEVELAND, OHIO

ASSISTANT TO VICE PRESIDENT IN CHARGE OF OPERATIONS
CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh, Pennsylvania

▲ THE steel industry today is faced with an unprecedented demand for tonnage. To meet the needs for national defense and to adequately and simultaneously satisfy the civilian requirements is a problem which will tax the ingenuity of our steel producers and require the concentrated effort of every employe of the industry. To the operating and engineering personnel of the industry, the problems of the moment are only too familiar, but I do not hesitate to say that the production problems of next month and next year will be far more difficult of solution than those with which we are confronted today.

Industrial mobilization in the United States is not new. Profiting by the experience of the last World War, plans for such mobilization have been in process of preparation for 16 years. Although these plans have been drawn on the basis of active participation, the present situation of adequate preparation for national defense and simultaneous "all out" aid to Britain increases rather than diminishes the demands on the producing facilities of the steel industry. The present situation presents a somewhat different picture from that conceived in the industrial mobilization plans of 1936 and 1939, the underlying philosophy of which was that the emergency powers of the government would be administered by emergency boards and commissions called into existence on the declaration of war, and whose extensive and far reaching authority would be automatically eliminated by the cessation of hostilities. Today the previously orthodox methods of declaring war have been discarded and hostilities are begun, after vociferous protestations of non-belligerency, by a wholesale and intensified invasion.

The transition from a nation completely absorbed in peaceful production to one in which a large percentage of industrial activity is engaged in the manufacture of defense requirements is not made easily and requires far-reaching alteration in manufacturing methods and schedules.

It demands tremendous extensions in those industries producing materials required in small volume for peacetime needs but in enormous quantities for defense purposes. It requires the construction of new industries and the wholesale transfer of personnel from peacetime industrial activity to a new and only partially developed field of war material production activity.

This change to an industrial mobilization, geared to defense requirements has already produced shortages in the raw materials of production—some due to inadequacy of supply, some due to difficulties of transportation and some due only to the accelerated rate of activity in those industries which are engaged in the manufacture of essential war material. Partly perhaps as a result of overtaxed transportation facilities and partly as a result of inordinate demand, industry is faced with a shortage of the types of fuel normally used in production, and it is with respect to fuel economy and fuel utilization that I would like to present certain facts and methods.

Simply to say that it takes 20 to 30 million Btu per ton of steel produced, and frankly I do not know how correct even that figure may be, means nothing to the steel producer and may, to the layman, when transferred into tons of coal equivalent, or gallons of fuel oil, convey some idea of the magnitude of the fuel requirement of the industry. To executives and engineers who are interested in the lowest cost production of quality products that will give satisfactory results, when processed in their customers' plants, fuels mean much more than mere pounds of coal or gallons of oil.

The metallurgical requirements of the steel industry clearly differentiate between fuels of high and fuels of low calorific intensity, between fuels which burn with luminous flame and those which do not, between the requirements of operations at high temperatures such as steel making and those which can be conducted at a lower temperature such as steam generation and annealing. The economical utilization of by-product fuels and the recovery of sensible heat in waste gasses, are vital factors. The production and maintenance of atmospheres of special composition at definite temperatures means success or failure in the complicated processing required for the production of a definite quality of product. The terms "controlled heating" and "controlled cooling" represent definite cycles, the maintenance of which is fundamental to correct processing.

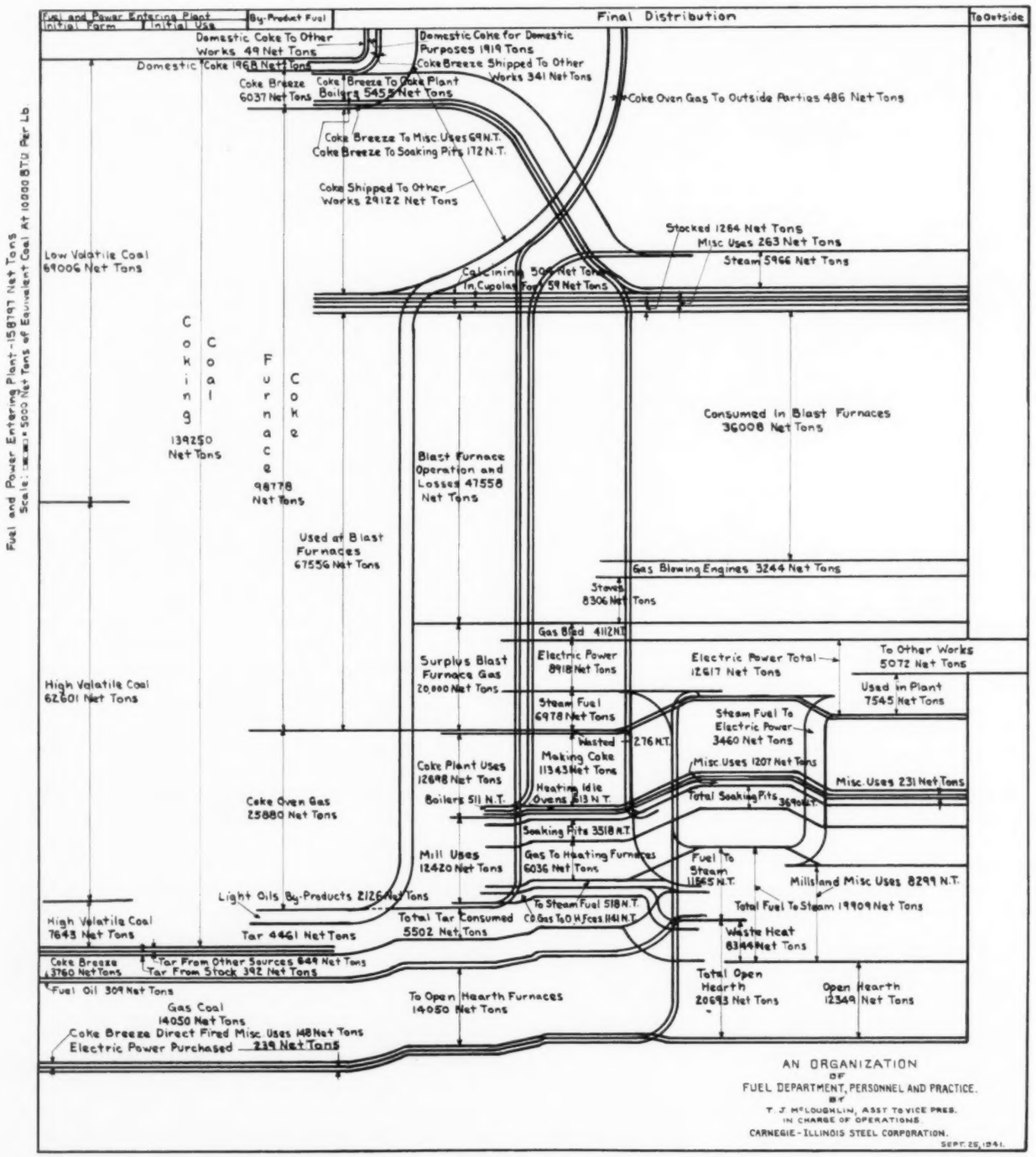
CHART I

FUEL AND POWER DISTRIBUTION

FUEL PRODUCTION AND CONSUMPTION

Fully Integrated Steel Plant -- Capacity 5,000,000 Tons Ingots per Year

Typical 7 Day Period at 100 Per Cent Operation


Fuel and Power Entering Plant
Initial Form
Initial Use
By-Product Fuel
Final Distribution
To Outside
Fuel and Power Entering Plant-158797 Net Tons
Scale: 1 cm = 5000 Net Tons of Equivalent Coal At 10000 BTU Per Lb
Domestic Coke To Other Works 49 Net Tons
Domestic Coke 1968 Net Tons
Domestic Coke for Domestic Purposes 1919 Tons
Coke Breeze Shipped To Other Works 341 Net Tons
Coke Breeze 6037 Net Tons
Coke Breeze To Coke Plant Boilers 5455 Net Tons
Coke Oven Gas To Outside Parties 486 Net Tons
Coke Breeze To Misc. Uses 69 N.T.
Coke Breeze To Soaking Pits 172 N.T.
Coke Shipped To Other Works 29122 Net Tons
Stocked 1264 Net Tons
Misc Uses 263 Net Tons
Steam 5966 Net Tons
Low Volatile Coal 69006 Net Tons
Calcining 304 Net Tons
In Cupolas For 59 Net Tons
Coking Coal 139250 Net Tons
Furnace Coke 98778 Net Tons
Consumed in Blast Furnaces 36008 Net Tons
Blast Furnace Operation and Losses 47558 Net Tons
Used at Blast Furnaces 67556 Net Tons
Gas Blowing Engines 3244 Net Tons
Stoves 8306 Net Tons
Gas Blast 4112 N.T.
Surplus Blast Furnace Gas 20,000 Net Tons
Electric Power 8918 Net Tons
Electric Power Total 12617 Net Tons
To Other Works 5072 Net Tons
Used in Plant 7545 Net Tons
High Volatile Coal 62601 Net Tons
Steam Fuel 6978 Net Tons
Steam Fuel To Electric Power 3460 Net Tons
Wasted 276 N.T.
Making Coke 11343 Net Tons
Misc Uses 1207 Net Tons
Misc Uses 231 Net Tons
Coke Plant Uses 12698 Net Tons
Heating Idle Ovens 513 N.T.
Total Soaking Pits 3690 N.T.
Boilers 511 N.T.
Coke Oven Gas 25880 Net Tons
Soaking Pits 3518 N.T.
Mill Uses 12420 Net Tons
Gas To Heating Furnaces 6036 Net Tons
Fuel To Steam 11565 N.T.
Millsland Misc Uses 8299 N.T.
Light Oils By-Products 2126 Net Tons
To Steam Fuel 518 N.T.
CO Gas To Open Hearth Furnaces 1141 N.T.
Total Fuel To Steam 19909 Net Tons
High Volatile Coal 7643 Net Tons
Total Tar Consumed 5502 Net Tons
Tar 4461 Net Tons
Waste Heat 8344 Net Tons
Coke Breeze 3760 Net Tons
Tar From Other Sources 649 Net Tons
Tar From Stock 392 Net Tons
Fuel Oil 309 Net Tons
Total Open Hearth 20693 Net Tons
Open Hearth 12349 Net Tons
Gas Coal 14050 Net Tons
To Open Hearth Furnaces 14050 Net Tons
Coke Breeze Direct Fired Misc. Uses 148 Net Tons
Electric Power Purchased 239 Net Tons
AN ORGANIZATION
OF
FUEL DEPARTMENT, PERSONNEL AND PRACTICE.
BY
T. J. McLOUGHLIN, ASST. TO VICE PRES.
IN CHARGE OF OPERATIONS
CARNEGIE-ILLINOIS STEEL CORPORATION.
SEPT. 25, 1941.

All of these things definitely point to the necessity of an accurate knowledge of the potentialities of each available fuel and to the necessity for the accurate maintenance of conditions known to produce the necessary physical requirement in the steels which customers must have. They illustrate also the necessity of technological development in the realm of temperature and combustion control which is essential if we are to keep pace with the ever-increasing demands for improved products.

The fuel requirements of a steel plant vary within wide limits depending on whether it is fully integrated or otherwise. Even among integrated plants, one finds many types. For example, a unit may be self-contained and balanced with respect to capacity of coke ovens, blast furnaces, open hearths, and finishing mills, and make up any fuel deficit by outside purchases. Other types of integrated plants may include coke oven capacity substantially in excess of the requirements for the individual plant to which it is attached, such excess coke normally being furnished to other consuming plants under the same management. Power and fuel interchanges between the plants may or may not exist. To illustrate the magnitude and complexity of the fuel problem under such conditions, I have prepared as Chart I a fuel distribution for such a plant capable of producing 5,000,000 tons of ingots per year and rolling this tonnage into rails, plates, structural material, strips and bars. The coke production in this particular case is approximately 40 per cent in excess of the plant's own requirement and is furnished to a sister plant in the same district. Chart I illustrates that the normal fuel requirement of the fully integrated plant, in terms of coal of 10,000 Btu content per pound, is 157,000 net tons per week of 100 per cent operation, or 22,500 net tons per day. The distribution of fuel to the various consumers of such a plant represents a complicated system and as shown by the chart is sub-divided among the various units in approximately the following percentages:

FUEL INPUT

	Per cent of total
Coking coal	87.7
Tar	.7
Coke breeze	2.4
Fuel oil	.2
Gas coal	8.9
Purchased power	.1
Total	100.0

FUEL DISTRIBUTION

	Per cent of total
Coke ovens	7.9
Blast furnaces	29.8
Steel producing units	13.3
Semi-finishing mills	2.4
Finishing mills	3.8
Steam and electric power	18.1
Surplus for use in other plants or sale	22.0
Wasted	2.7
Total	100.0

The distribution of fuels in such a plant varies considerably with different rates of operation. The fuel consumption of the above mentioned plant at 50 per cent operation is between 65 and 70 per cent of the consumption at full operation. This, of course is due to maintaining temperature in such facilities as idle coke ovens, soaking pits, heating furnaces, etc.

A fuel distribution at 50 per cent operation with 65 per cent operation at coke plant is as follows:

FUEL INPUT

	Per cent of total
Coking coal	81.9
Coke breeze	2.4
Steam coal	3.1
Fuel oil	.4
Gas coal	12.0
Purchased power	.2
Total	100.0

FUEL DISTRIBUTION

	Per cent of total
Coke ovens	8.5
Blast furnaces	22.4
Steel producing units	13.3
Semi-finishing mills	4.1
Finishing mills	3.1
Steam and electric power	17.2
Surplus for use in other plants or sale	30.7
Wasted	.7
Total	100.0

While the total figures on a percentage basis may not indicate a wide variation between 100 and 50 per cent operation, the hourly load factor by units varies from zero to 100 per cent. Under operation at 50 per cent of capacity, the staggering of operating units in order to prevent wastage of surplus and by-product fuels and secure the most efficient operation, presents a difficult problem.

In a plant of this size the responsibility for the efficient use of fuel, for the economical development and utilization of power and for ordering and scheduling necessary maintenance, might advantageously be centralized in a divisional superintendent. The specification of such a supervisory position might be stated as follows:

Title—Division Superintendent, Fuel and Power
Reports to—Plant General Superintendent

SCOPE OF RESPONSIBILITY

First level supervision of producing and auxiliary operations of the following:

1. Steam generating units.
2. Gas washing plants.
3. Electric generating units.
4. Blast furnace blowing units.
5. Major pumping stations.
6. Mill motors and engines driving rolls, hydraulic pumps, air compressors, motor-generator sets, substations, switchboards and auxiliaries.
7. Operating responsibility for all coke oven gas

(after booster station), acetylene, oxygen, hydraulic water, steam and compressed air lines to consumers boundary.

8. Economical fuel practice at coke ovens, blast furnace stoves, open hearth furnaces, soaking pits, re-heating furnaces, power generating equipment, heat treating and miscellaneous furnaces.
9. Fuel jurisdiction—blast furnace gas, coke oven gas, fuel oil, tar, coal, coke breeze, station generated acetylene and oxygen.

Subordinates:

Assistant Division Superintendent, Fuel and Power

Assistant to Division Superintendents—Fuel Engineering, Personnel, Maintenance, Industrial Relations, Power Scheduling.

Specific duties:

Coordinate and direct work of subordinates.

General duties:

Planning, research.

Consulting with:

Division Superintendents.

Advising with:

Engineering Division.

The scope of activity and responsibility of such a fuel division extends to every manufacturing department of a large plant and involves careful coordination within such manufacturing divisions in the interest of maintaining accurate heat cycles, of maintaining efficient production rates and of assuring the economical use of fuels. From the temperature cycles at the coke plant to the accurately controlled cycles of the heat-treating department in the finishing mills, there is encountered every conceivable problem in fuel engineering, and the coordinated effort of producing departments and fuel technologists is necessary to insure quality and low cost of product. I cannot emphasize too strongly the inter-dependence of operators and engineers in securing that efficiency which means a satisfactory product delivered to customers at a fair price and with a profit to the producer.

An analysis of the functional responsibilities shown in Chart II may be subdivided:

(1) Fuel combustion, metering, control, distribution, application.
(2) Power and sub-station facilities.
(3) Operation of steam generating facilities.
(4) Operation of blast furnace blowing units.
(5) Operation of pumping units.
(6) Operation of steam and electrical prime movers.
(7) Operation of oxygen supply and cutting gas generating units.

In discussing a preliminary draft of this paper with some of the fuel engineers of my own company it was suggested that a more detailed outline of the function and responsibility of the assistant to division superintendent—fuel engineering, would be interesting to many of you. My conception of this position is that above all else its primary function is educational. Its responsibilities are for the education of personnel, the economical consumption of fuel in all divisions and departments, the satisfactory operation of metering and control apparatus, the economical distribution of available fuels, the development of standard practices and procedures and technological research in the field of combustion.

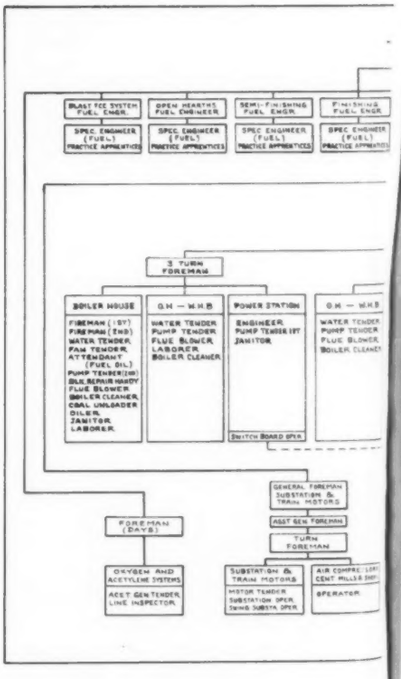
To be more specific, let us take the position of open hearth fuel engineer and set down the functions of this job. They are:

(1) Educational work among furnace helpers.
(2) The determination of efficient furnace fuel cycles.
(3) The checking of combustion on furnaces, mixers, cupolas, waste heat boilers, etc.
(4) The measurement of all fuels, air, steam, water, oxygen, etc., used.
(5) The continuous functioning of control apparatus.
(6) The development of standard practices and procedures.

In the development of any organization the function and responsibility of each member of the supervisory personnel should be fully and carefully defined to the end that each supervisor may be informed of what is expected of him.

A statement of the functions and responsibilities assigned to other departmental fuel engineers would be somewhat similar to those of the open hearth. I have, at times, been asked regarding the cost of such a department and estimates show that from one-fourth to one-half of one per cent of the value of the fuel consumed is adequate to cover the total expense. Such a division, well operated, can show a handsome return on the annual expenditure involved.

In many smaller plants the allocation of the above responsibilities within the organization varies so that the fuel combustion, metering, control and distribution may be the responsibility of an individual who may report to the plant superintendent, to the chief me-



chanical engineer, or to the superintendent of maintenance. In other plants fuel and steam generation may be combined. In many cases the fuel engineer, who may rank as a department head or as an assistant to the chief engineer or maintenance superintendent, may have only consulting and advisory responsibility in the operation of steam generating, pumping, blowing, power generation and mill power drives.

In many of the larger steel manufacturing plants, the production of utilities—water, compressed air, steam, electric power, cutting gas, etc., until recent years, have been considered of minor importance and the responsibility for their economical production has been delegated to those whose primary responsibility was maintenance or engineering. Because of the necessity for minimum cost production during the years since 1932, the role of utilities in the total manufacturing cost became of greater importance, and specialists were placed in charge of their production.

The past ten years have seen a tremendous change in steel manufacturing methods, brought about by the necessity of producing a specialized product to meet each specific need of the consuming industries. This so-called tailor made age of steel introduced more extensive and more accurately controlled processing. The controlled heating and controlled cooling cycles which today are recognized as essential to satisfactory production, required the specialized knowledge of the fuel technologist.

In the large steel plant of today the accurate control of combustion and the efficient production of utilities has become an entirely separate function, organized and staffed on the same basis as the public utility corporations who furnish the water and light, and in some cases heat, to our homes and office buildings. Maintenance, which in past years, has been the function of the master mechanic and the electrical superintendent, have in the interest of economy been organized as a single unit, divorced from operation and devoted solely to maintenance of all plant equipment.

Regardless of plant size, however, economic considerations indicate that responsibility for fuel consumption and utilities production should be concentrated under a single jurisdiction with an allocation of responsibilities within that jurisdiction best suited to meet local conditions.

The present day fuel and power division of a steel mill presents to management all the problems found in a typical manufacturing enterprise, ranging from material procurement, sales and waste product disposal. To direct a fuel and power division of such a steel plant; to coordinate its activities, and to obtain a maximum overall economy, an accurate knowledge of producing costs is essential. The requirements may be suitably met by a standard cost system combined with budgetary control under which utilities are furnished to producing units at a fixed or standard cost and the fuel and power division operated as a separate cost entity.

One of the principal features of such a standard cost system that is of particular value in obtaining operating control is the fact that incurred costs are associated

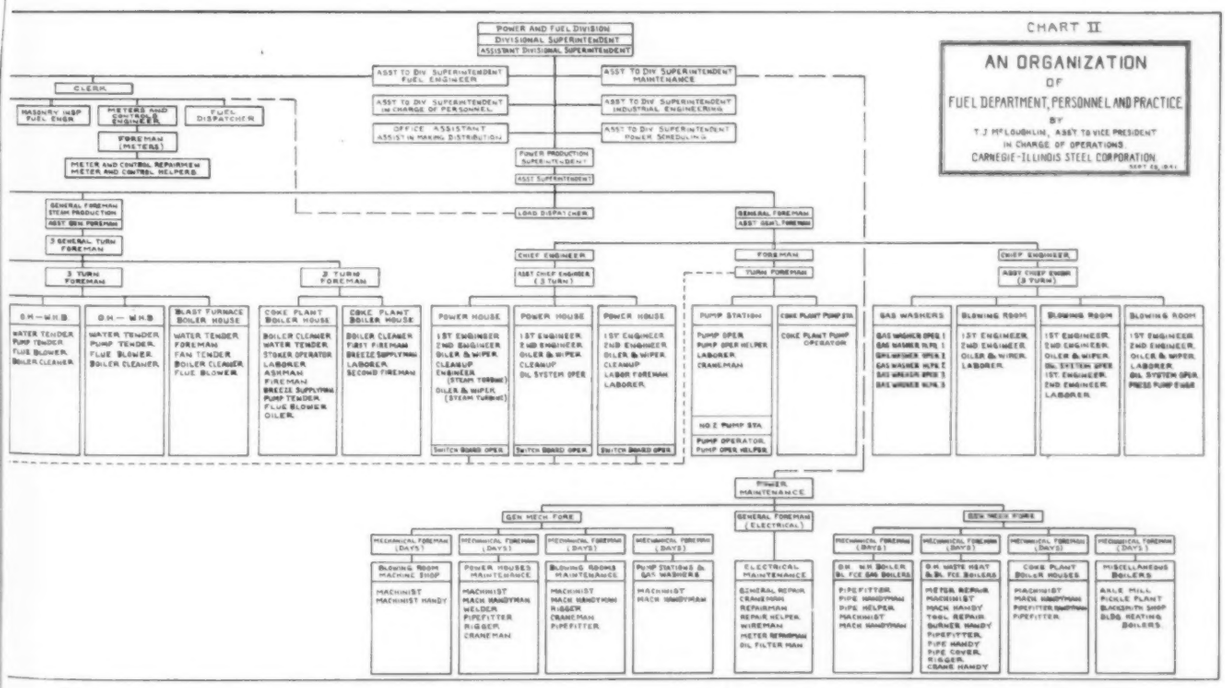


CHART II
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POWER AND FUEL DIVISION
DIVISIONAL SUPERINTENDENT
ASSISTANT DIVISIONAL SUPERINTENDENT
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FUEL DISPATCHER
FOREMAN (METERS)
METER AND CONTROL REPAIRMEN METER AND CONTROL HELPERS
ASST TO DIV SUPERINTENDENT FUEL ENGINEER
ASST TO DIV SUPERINTENDENT IN CHARGE OF PERSONNEL
OFFICE ASSISTANT ASSIST IN MAKING DISTRIBUTION
ASST TO DIV SUPERINTENDENT MAINTENANCE
ASST TO DIV SUPERINTENDENT INDUSTRIAL ENGINEERING
ASST TO DIV SUPERINTENDENT POWER SCHEDULING
POWER PRODUCTION SUPERINTENDENT
ASST SUPERINTENDENT
LOAD DISPATCHER
GENERAL FOREMAN STEAM PRODUCTION
ASST GEN FOREMAN
3 GENERAL TURN FOREMAN
3 TURN FOREMAN
2 TURN FOREMAN
CHIEF ENGINEER
ASST CHIEF ENGINEER (3 TURN)
FOREMAN
TURN FOREMAN
GENERAL FOREMAN
ASST GEN FOREMAN
CHIEF ENGINEER
ASST CHIEF ENGR (3 TURN)
O.H. — W.H.B.
WATER TENDER PUMP TENDER FLUE BLOWER BOILER CLEANER
O.H. — W.H.B.
WATER TENDER PUMP TENDER FLUE BLOWER BOILER CLEANER
BLAST FURNACE BOILER HOUSE
WATER TENDER FOREMAN FAN TENDER BOILER CLEANER FLUE BLOWER
COKE PLANT BOILER HOUSE
BOILER CLEANER WATER TENDER STOKER OPERATOR LABORER ASHMAN FIREMAN BREEZE SUPPLYMAN PUMP TENDER FLUE BLOWER OILER
COKE PLANT BOILER HOUSE
BOILER CLEANER FIRST FIREMAN BREEZE SUPPLYMAN LABORER SECOND FIREMAN
POWER HOUSE
1ST ENGINEER 2ND ENGINEER OILER & WIPER CLEANUP ENGINEER (STEAM TURBINE) OILER & WIPER (STEAM TURBINE)
SWITCH BOARD OPER.
POWER HOUSE
1ST ENGINEER 2ND ENGINEER OILER & WIPER CLEANUP OIL SYSTEM OPER
SWITCH BOARD OPER.
POWER HOUSE
1ST ENGINEER 2ND ENGINEER OILER & WIPER CLEANUP LABOR FOREMAN LABORER
SWITCH BOARD OPER.
PUMP STATION
PUMP OPER PUMP OPER HELPER LABORER CRANEMAN
NO. 2 PUMP STA.
PUMP OPERATOR PUMP OPER HELPER
COKE PLANT PUMP STA.
COKE PLANT PUMP OPERATOR
GAS WASHERS
GAS WASHER OPER 1 GAS WASHER HLPR 1 SPRAYWASHER OPER 2 GAS WASHER HLPR 2 GAS WASHER OPER 3 GAS WASHER HLPR 3
BLOWING ROOM
1ST ENGINEER 2ND ENGINEER OILER & WIPER LABORER
BLOWING ROOM
1ST ENGINEER 2ND ENGINEER OILER & WIPER OIL SYSTEM OPER 1ST ENGINEER 2ND ENGINEER LABORER
BLOWING ROOM
1ST ENGINEER 2ND ENGINEER OILER & WIPER LABORER OIL SYSTEM OPER PRESS PUMP FIRER
POWER MAINTENANCE
GEN MECH FORE
GENERAL FOREMAN (ELECTRICAL)
GEN MECH FORE
MECHANICAL FOREMAN (DAYS)
BLOWING ROOM MACHINE SHOP
MACHINIST MACHINIST HANDY
MECHANICAL FOREMAN (DAYS)
POWER HOUSES MAINTENANCE
MACHINIST MACH HANDYMAN WELDER PIPEFITTER RIGGER CRANEMAN
MECHANICAL FOREMAN (DAYS)
BLOWING ROOMS MAINTENANCE
MACHINIST MACH HANDYMAN RIGGER CRANEMAN PIPEFITTER
MECHANICAL FOREMAN (DAYS)
PUMP STATIONS & GAS WASHERS
MACHINIST MACH HANDYMAN
ELECTRICAL MAINTENANCE
GENERAL REPAIR CRANEMAN REPAIRMAN REPAIR HELPER WIREMAN METER REPAIRMAN OIL FILTER MAN
GEN MECH FORE
MECHANICAL FOREMAN (DAYS)
O.H. W.H. BOILER OIL FCE GAS BOILERS
PIPEFITTER PIPE HANDYMAN PIPE HELPER MACHINIST MACH HANDYMAN
MECHANICAL FOREMAN (DAYS)
O.H. WASTE HEAT & OIL FCE BOILERS
METER REPAIR MACHINIST MACH HANDY TOOL REPAIR BURNER HANDY PIPEFITTER PIPE HANDY PIPE COVER RIGGER CRANE HANDY
MECHANICAL FOREMAN (DAYS)
COKE PLANT BOILER HOUSES
MACHINIST MACH HANDYMAN PIPEFITTER HANDYMAN PIPEFITTER
MECHANICAL FOREMAN (DAYS)
MISCELLANEOUS BOILERS
ANLE MILL PICKLE PLANT BLACKSMITH SHOP BLDG. HEATING BOILERS

with definite responsibilities and not accumulated to particular products. However, a standard cost system does not prevent determination of actual cost by products, which may be obtained by adding plus or minus variances to standard product costs when such product costs are required. Responsibilities, as developed in a standard cost system, are really control areas or centers which are supervised by a responsible individual. By segregating a plant into a number of well defined responsibilities, one of which is a fuel and power division, plant management is currently informed as to the amount of money expended by such responsible division, and those in charge of such divisions, in turn are currently informed of the expenditures of each responsibility within the division. Thereby, an effective cost control can be established and waste or losses caused by duplication of effort on the part of isolated supervisors avoided. Since the extent of cost variation from standard is asscciated with a definite individual, it is possible for higher management to judge more effectively the capabilities of responsibility heads as supervisors, and therefore, better place competent personnel in positions of authority.

In a fuel and power division, one of the principal problems is the coordination of the various producing or service activities in order that overall costs may be a minimum. The sub-division of the plant into control centers or responsibilities and the establishment of predetermined performance standards for each, facilitates the determination of effect of changes in one unit on the operations or costs within succeeding units.

The fact that under a standard cost system inefficiencies in prior responsibilities are not snow-balled into subsequent ones, makes analysis of current cost variations much easier and gives management a much better opportunity to see why cost variations have occurred. By the isolation of variances between controllable and uncontrollable factors, for example plant performance versus price of materials purchased or production volume, much tedious detail is eliminated when cost analyses beyond those currently exhibited on operating statements are required.

I have dwelt at some length on the application of a standard cost system and budgetary control procedures to the production of utilities and all that has been said regarding such a system may be applied equally well to producing divisions of a steel mill. Aided by such control devices the production and use of utilities in a steel plant may be efficiently handled by the type of organization I have indicated in Chart II.

DISCUSSION

PRESENTED BY

J. L. MILLER, *Assistant Chief Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio

A. J. FISHER, *Fuel Engineer,* Bethlehem Steel Company, Sparrows Point, Maryland

C. J. WYROUGH, *Superintendent,* Steam and Combustion, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

T. J. McLOUGHLIN, *Assistant to Vice President of Operations,* Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

E. T. W. BAILEY, *Combustion Engineer,* Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

E. E. CALLINAN, *Combustion and Refractories Engineer,* Timken Roller Bearing Company, Canton, Ohio

J. L. MILLER: I am very much interested in the subject that Mr. McLoughlin talked about. I have often wondered what was the best and the ideal way to set up a fuel engineering department. There is considerable food for thought in this entire paper. In principle, I think the paper gives a sound method of installing a fuel engineering department in a plant. The details further down the line as to how far management wants to go to get into the operation and maintenance of the equipment may be a subject of debate and discussion.

A. J. FISHER: I was very much interested in Mr. McLoughlin's paper. I happen to work in a plant of about the same size and capacity, which he has just illustrated to you. We, in our own company, are not entirely agreed on just what is the best way to operate a fuel department. We have two plants where the power and fuel departments are combined and three plants where they are separated. I work in one of the larger plants where they are separated.

Our fuel department deals with the power department in the same manner that it does with the other departments of the plant such as coke ovens, blast furnaces, open hearths, etc. The advantage of this arrangement is that it keeps all the work that the fuel department does of the same character, namely, engineering, consulting, instruments, and controls.

By relieving the fuel department of routine operating problems, more time is available for improved furnace practice and furnace efficiency. It appears to me that the greater plant savings can be made in this manner.

There are very large potential savings that can be made in most steel plants by the regulated utilization of fuels, and the fuel department's efforts should be entirely spent in this manner.

C. J. WYROUGH: Mr. Fisher spoke about mechanical equipment. It has a fairly uniform cost so long as it is properly maintained. If it is not maintained, those costs can go very high. Some organizations have the fuel department combined with the mechanical and in others it is entirely separate. I would like to ask Mr. McLoughlin, in a plant where it is separate, what his opinion is as to the function of the fuel department with respect to the mechanical equipment—the maintenance of it to keep your fuel rates down.

T. J. McLOUGHLIN: The responsibility of the fuel and power division is for timing and ordering all maintenance work. The efficient performance of mainte-

nance work is the responsibility of the maintenance department.

I might say that the organization illustrated in Chart II is not theoretical. It is an actual working organization in existence today, and it is showing results.

E. T. W. BAILEY: I would like to see a companion chart, similar to the one shown, for a much smaller plant.

T. J. MCLOUGHLIN: The same general type of organization is in operation with a small plant.

E. T. W. BAILEY: I wouldn't think they could afford it.

T. J. MCLOUGHLIN: Yes, very definitely it is an economy.

E. E. CALLINAN: I was very much interested with respect to the emphasis which Mr. McLoughlin put on the educational features of combustion work. Naturally, there are several ways in which the education, coming right down to the furnace operator, for example, could be accomplished. I wonder if Mr. McLoughlin would give us his views on that.

T. J. MCLOUGHLIN: In this type of organization you have a small group whose function is to educate the personnel of the particular department. A good part of it is accomplished by personal contact. Some years ago when I had charge of a fuel department in one of the Carnegie-Illinois plants, we had an organization consisting of two and sometimes three men in the open hearth, whose primary responsibility it was to inform helpers of the particular things they should avoid and what things they should look for. Today, we set up standard process control and point out to operating personnel the best means of attaining this objective. That is something which must be followed up every day if you are going to reproduce from day to day the cycle of operation which is known to give you a satisfactory product. The most important thing we face today is to so control our operations that each piece of steel going out of the plant will give uniformly satisfactory results when processed by our customers.

A. I. S. E. District Section Activities

BIRMINGHAM, April 11, 1:30 P.M.—Inspection Trip, Atlantic Steel Company, Atlanta, Georgia. "Selection of Steel for Galvanizing", by R. W. Sandelin, Chief Metallurgist, Atlantic Steel Company, Atlanta, Georgia.

CHICAGO, April 7—"Personnel Development and Training", by Russell Greenly, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

CLEVELAND, April 20
YOUNGSTOWN, April 21 **"Reclamation of Palm Oil and Transformer Oil", by R. P. Dunmire, Buckeye Laboratories Company, Cleveland, Ohio.**

DETROIT, April 14—"Recovery of Steel from Open Hearth Slag", by F. E. Ulman, Assistant to the President, The Hackett Corporation, Butler, Pennsylvania.

PHILADELPHIA, April 4—Maintenance Symposium—P. S. Armstrong, Superintendent of Filtration, Bureau of Water, City of Easton, Pennsylvania; W. H. Beyerle, Assistant Superintendent, Electrical Department, Bethlehem Steel Company, Sparrows Point, Maryland; G. C. Pfeffer, Superintendent of Power, Florence Pipe Foundry and Machine Company, Florence, New Jersey; and W. A. Smiley, Electrical Department, Bethlehem Steel Company, Steelton, Pennsylvania.

PITTSBURGH, April 13—"Protection of Plant Equipment from Sabotage", by E. J. Rose, Special Agent, Federal Bureau of Investigation. "Engineering for Increased Production in the Steel Industry", by R. H. Wright, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

GROUNDED D-C SYSTEMS for Steel Mills

By L. L. Fountain and H. A. Travers

Switchgear Division, WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Penna.

Presented at A. I. S. E. SPRING CONFERENCE
YOUNGSTOWN, OHIO

▲ LIKE many apparently simple problems in electrical engineering, it might seem at first thought that a definite yes or no answer could be quickly determined—at least from a theoretical analysis as to whether or not d-c systems in steel mills should be operated with one polarity grounded. Theory and practice should agree in the broad aspects of any problem, particularly where experience of some two decades of steel mill electrification have developed methods of operation for d-c systems.

John Stewart Mill, an English philosopher and political economist of the early part of the 19th century, gave a definition of the word "theory" that can well be kept in mind when applied to electrical problems, although he probably knew little, if anything, of electricity. His conception is stated as follows: "In its most proper acceptations, theory means the completed result of philosophical induction from experience."

All of us have changed our theories in engineering as we have gained experience from practical operation of electrical systems, particularly in steel mills. It is here that we find a more diversified practice possibly than in many industrial electrifications because of conditions more severe than in other commercial enterprises. Local surroundings in steel mills impose severe conditions not generally prevalent in other electrified industries and therefore have an important bearing on what may be considered best overall practice, as a very large percentage of the dust suspended in the air is highly conducting. In any large, or for that matter, small steel mill one can find ample justification for apparently contradictory methods of operation in different parts of the electrical distribution systems.

Let us then arbitrarily classify the d-c electrical systems around a typical steel plant in order to arrive at a rational analysis of whether these systems can best be operated with one polarity (usually the negative) deliberately and thoroughly grounded or whether better overall results will be obtained by keeping both polarities ungrounded.

GENERAL D-C MILL CIRCUITS

D-c 250 volt power distribution seems well adapted for general steel mill service. The prevailing practice in the design of 250 volt d-c generators, converters and motors contemplates that such machines will be normally operated ungrounded. No flash barriers around the commutators are provided as they introduce complications in mechanical design of such machines. Consequently, if one polarity is definitely grounded, then full potential exists between the opposite polarity and the frame of the machine, since the latter from a human safety standpoint, should be and usually is, well grounded. Any breakdown in the insulation between ground and the "hot" side of the circuit will cause a substantial short circuit if there is little resistance between the source of generation and the point of insulation failure. Such breakdowns may cause considerable damage to a motor and require replacement of armature iron laminations. The frequency of such failures is a direct function of maintenance in keeping the d-c machines cleared of the prevalent dirt and ore dust that the steel mills are inherently faced with. In the power houses or substations, where the generators and converters are located, the maintenance problem is comparatively simple and very few insulation failures occur on these machines or in their control equipment. The motors and their control for general mill service present a more difficult problem as well as distribution circuit particularly those for traction purposes. Then why not operate ungrounded. Well, some plants do, others do not. Let us review some of the factors for this difference in practice.

A normally ungrounded system if it can be kept free from grounds would obviously be an ideal system. However, it means eternal vigilence and prompt maintenance to keep it in such condition. Ground detectors, either lamp or instrument type, are the only practical means of indicating the occurrence of a ground on a

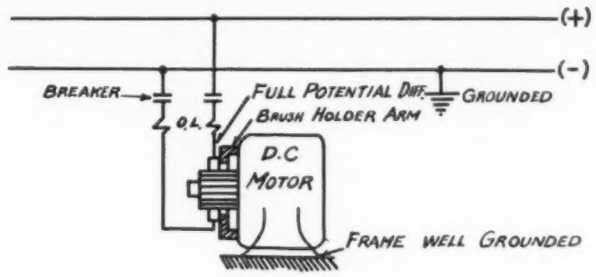


Figure 1—Close clearance points between grounded frames of machines and live parts constitute a source for grounds.

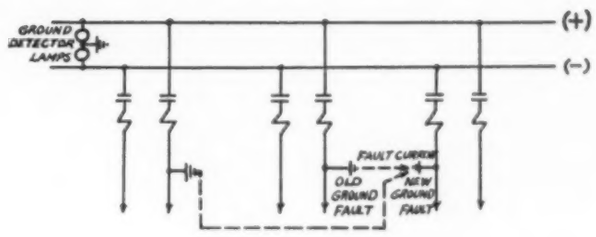


Figure 2—Grounds on the same polarity of different feeders show only on the ground detector until a ground on the opposite polarity faults all grounded feeders.

normally ungrounded d-c system. Since these indicators operate on the absence of potential between true ground and one of the two polarities of the d-c system they cannot indicate the particular point where the d-c system has become grounded. To locate and clear such grounds one or both of two methods are available. One method is to open each main distribution circuit one after another to determine on which circuit the ground has occurred. Then the various branches on this main circuit must be opened in sequence to determine whether the ground is on a branch or on the main feeder. Having located the circuit that is grounded it is then inspected for likely places where grounds might occur and when found, are removed. Some times this hunt may approach the "search of the needle in the hay stack."

All this requires personnel, time, and power interruption. What usually happens is continued operation of the normally ungrounded system, with one polarity grounded until a convenient time occurs to hunt the ground. The more intense the production activity, the ess there is of convenient time to hunt and clear up grounds. Now if multiple grounds always occurred on the same side of d-c circuits, conditions wouldn't be so bad. However, as soon as one polarity of the d-c system becomes grounded in one or more places, usually more, then, at a most inopportune time, the other polarity goes to ground and several circuits or motors are out of service and a large amount of maintenance occurs at once, which is often a very serious operating problem.

As an aid to clearing elusive grounds, the practice of "burning grounds clear" is quite frequently employed. The technique varies in different plants depending somewhat on the power concentration of the system. One quite simple and effective way is to "short" the feeder known to be grounded through a limiting resistor at its supply source, thus keeping the disturbance at the point of ground to a minimum.

Traction circuits naturally adapt themselves most readily to grounded d-c systems. In fact they are rather difficult and more expensive to operate ungrounded.

Figure 3—Light grounds can be burned clear, by purposely causing a heavy ground current to flow.

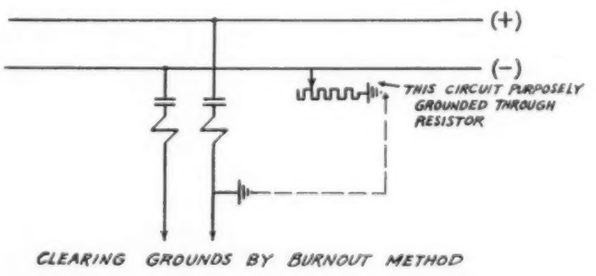
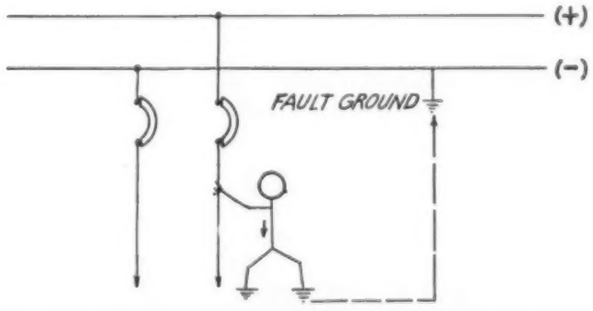


Figure 4—Unknown grounds can cause serious injury to operating personnel.



From a safety standpoint an ungrounded system, if it can be so maintained at all times, would be ideal. This, however, is generally not feasible and, further, there is no satisfactory way to keep everyone informed that today there is a ground on the positive side and tomorrow it is on the negative side. It would seem, therefore, that better safety practices can be realized by recognizing that the positive side of the circuit is "hot" at all times and treating it accordingly.

In view of the foregoing, there may be considerable justification to operate 250 volt d-c general mill systems with one side grounded. In doing so, however, full recognition must be given to certain factors that should be obvious. The more important ones are worthy of mention.

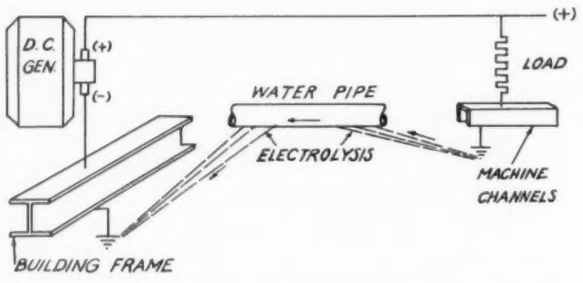


Figure 5—Serious damage to property can be caused by an all earth return circuit.

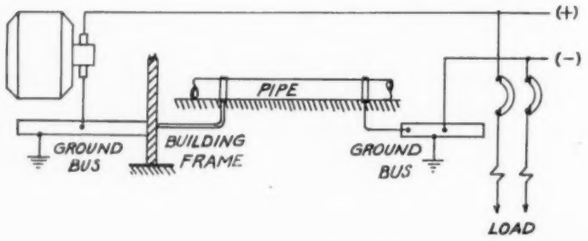
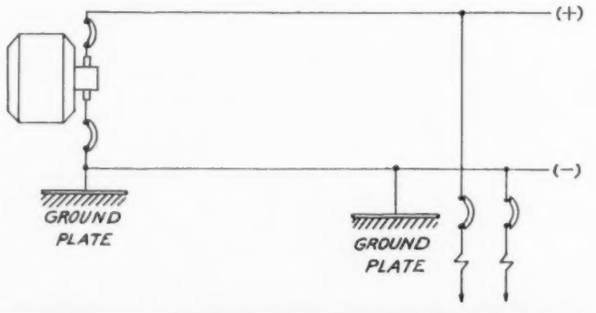


Figure 6—A return circuit through building frames, pipes etc., sets up hazards that should be avoided.

▲

Figure 7—A complete copper return circuit should be provided even though the circuit is grounded.



At first thought, one might be tempted to eliminate the copper conductors in the grounded side of the circuit, relying on the steel framework of the buildings and the rails of traction systems to return the current to the power supply units whose negative side (usually) is, of course, thoroughly grounded. Such a practice however, leads to a number of ills, some of which may become quite serious.

Since the resistance of steel is many times that of copper, there is considerable power loss and poor voltage regulation where large amounts of current must be handled. The return current seeking paths of least resistance does not confine itself to any particular channel but flows through soil where damp or wet, back through water and other piping and any other path that offers low resistance. This in turn may cause electrolysis troubles that are most apt to be hidden for some time before the cumulative effects are noticeable. Under short circuit conditions poor connections at bolted steel members generally cause burning or welding, and quite frequently produce safety hazards. Good operating practice therefore, dictates the use of equivalent copper in the grounded side of the system as would be provided in the ungrounded conductors. then adequate bonding of building steel to the well grounded copper return circuit. Similarly, rail joints should be adequately bonded and the negative rail return of traction circuits connected to negative copper returns where considerable amount of power is used in such traction circuits.

Some savings in control equipment can be made by using single polarity circuit breakers and switches in the main distribution circuits as is the practice in d-c street railway systems. However, automatic circuit breakers and switches should be used in both polarities of generators, converters, and rectifiers to protect them from internal grounds. Control for motors should in general use standard equipment, have over-current devices in both sides of the circuit because of possible regenerative possibilities and the relatively small savings realized by the omission of one overcurrent element. The usual standard magnetic control equipment can be used for grounded or ungrounded d-c systems. Manual control equipment for crane motors should have isolating devices in both sides of the circuit for obvious safety reasons.

LARGE D-C MILL DRIVES

For d-c systems used for finishing stands of strip mills and the like, higher voltages are usually necessary on account of the power involved and usually operate at 600 volts. Here the motors and generators are invariably located in isolated control rooms where the problem of cleanliness is an important factor to satisfactory operation. The machines are not supplied with flash barrier at the commutators and obviously an ungrounded system is indicated and used. Associated lower voltage d-c auxiliary systems should likewise be operated ungrounded for obvious reasons.

From the foregoing discussion our attitude to grounding of d-c systems in steel mills may be briefly summarized as follows:

(1) For expensive equipment well housed and ade-

quately maintained, ungrounded d-c systems are favored.

(2) For general mill service either the ungrounded or the grounded system can be used. Local practice, conditions and preference have a large influence for each specific case.

(3) Mills having finishing departments only which are relatively clean can preferably be operated ungrounded.

(4) In plants having blast furnaces, open hearths, coke ovens, soaking pits and large hot mills throwing off considerable scale, the grounded system appears to have more advantages than disadvantages from an operating standpoint if recognized good installation practices are used. With such a system, any ground occurring on the ungrounded side of a machine will immediately be removed from the system through suitable protective means associated with the machine control equipment.

DISCUSSION

PRESENTED BY

F. W. CRAMER, *Electrical Engineer,* Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

W. A. PERRY, *Superintendent,* Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Indiana

L. V. BLACK, *Superintendent,* Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

I. N. TULL, *Electrical Superintendent,* Republic Steel Corporation, Cleveland, Ohio

H. R. MIDDLEBROOK, *Assistant Division Superintendent,* Power and Fuel, Carnegie-Illinois Steel Corporation, Gary, Indiana

H. A. TRAVERS, Switch Gear Division, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

F. W. CRAMER: A paper such as this one is a very difficult thing to write, and I appreciate what the authors have done. It is one of these subjects on which we have quite a diversified opinion. If they were talking about street railways, I do not think there would be any argument about a grounded or ungrounded system, for they all run with the grounded systems. It is the same with our mines. But in the steel mills, we have a different problem.

There were several descriptions presented here of ungrounded systems. I think one of our major plants used another one which he didn't show: the balancer set, where the set is in a heavy resistance in the circuit through the neutral. It operates a relay, which cuts out the resistance, burns the ground off, and, according to the plant, that burns fine.

Most steel plants, unfortunately, run grounded against their will. They have ground on practically all the time. The damage it does is a matter of opinion among the men in the mill. The chief objection to the grounded systems in the steel mills is electrolysis. That is a hard job to lick, and you are likely to run into a great deal of expense with your water line and gas line under ground. Electricity has a habit of taking the shortest path back to the power house, regardless of which way the wires run.

I was glad to hear the conclusion of the paper, that this is a matter for individual plants to decide. Conditions in one plant are different from another plant, so I agree with the authors that it is a matter of opinion as to where you should have grounded systems or ungrounded systems.

W. A. PERRY: This subject is somewhat similar to and antedates the one of grounded neutral a-c systems. Personally, I am not in favor of either the grounded d-c system or the grounded neutral a-c system in a steel mill, but I do know there are many more engineering reasons for the grounded neutral a-c system than there are for the grounded d-c system.

It so happens that we have had actual experience in a steel mill that started with an ungrounded, intentional, d-c distribution system. With a change in supervisory personnel and new ideas due to the supervisor having had traction system experience we converted this system to a grounded d-c distribution system. This was so troublesome that this traction system idea of a grounded d-c system did not last long in our steel plant.

Primarily, all these changes and ideas are revolving around the idea of lower total over-all operating cost and we should consider the total over-all cost of any scheme before we adopt it or change our present operating systems.

In the case of grounded d-c distribution systems we know that we have a choice of saving money on installed wiring and then spending several times that figured saving on structural steel, piping and other mechanical repairs.

For successful operation of the grounded d-c system it is necessary to provide an adequate return path to your power supply. For example, let us assume that a modern crane is to be operated upon the grounded system. Since this is a modern crane it will be equipped with anti-friction bearings and there are several cases where anti-friction bearings have caused enough worry without using them as a return path for several hundred amperes. If you bond or jumper all these points it seems to me no saving has been accomplished in the wiring system.

It would not be possible to operate your plant with a fewer number of employes, therefore you have made no saving in this particular field.

The experience we had indicated a decided increase in manual controller maintenance and severity of damage to rotating equipment plus the additional delay to operating units due to immediate outage of the equipment due to accidental grounds.

You cannot hope to reduce repair cost by going to a grounded d-c distribution system. In my opinion, this can only be accomplished by maintenance work.

L. V. BLACK: It is customary, in the operation of a d-c distribution system, to depend upon the same general performance of equipment as when newly installed. Those of you who are actively engaged in

maintenance of electrical equipment in steel mills know that this dependence is seldom realized and certainly not justified, unless a survey has been made involving the four main factors imposed upon any distribution system; the class of service to be rendered; the safety factors and the quality of equipment; the duty cycle imposed upon the system; and the local conditions of atmosphere and temperature. Because of these factors, the determination of whether an ungrounded or grounded d-c distribution system constitutes an adequate power setup is not subject to universal standardization.

Since this subject is highly controversial and may be argued pro and con I would prefer to confine my remarks to past operating experience, such as we have encountered during the past twenty years or more in connection with operating d-c distribution systems in our Bethlehem plant, both ungrounded and grounded.

Prior to 1927, we had been operating all of our d-c systems ungrounded, except one. We were always confronted with floating grounds having a value of potential ranging anywhere from 0 to full system voltage on either polarity, so that in fact the so-called "ungrounded" systems were in reality always grounded. It was practically impossible to discover the exact location of the grounds and therefore very little could be done to control them. Furthermore, it was impossible to keep proper parties informed from time to time as to the degree of grounding of the so-called "ungrounded" systems.

During the latter part of 1926, we dismantled our main gas engine d-c generating station and installed several new d-c substations and decided at that time to give the grounded system a trial.

Very briefly, what we did was to install all d-c feeders with the same amount of copper in both legs the entire feeder length, and since in the majority of cases these feeders supplied shops having cranes, the negative feeder was solidly grounded to the crane runway. A copper conductor equal in size to the positive conductor for the crane feed, was installed between the shop feeder and the crane girder. In no case did we ground a negative d-c bus at the substation end. We feel by grounding each individual feeder in this manner, the ever present electrolysis problem is reduced to a minimum. We feel it is important that all radial feeder to a substation be grounded to insure proportionate return negative currents for individual feeders equal to positive currents. Otherwise severe overloading with damaging results may be experienced to some negative return feeders, or substation switchgear, having the better current carrying characteristics.

Because of this method of grounding the negative feeder to crane runways we have been able to replace the two conductor trolley wire crane feed conductors with one substantial crane angle conductor at exactly one-half of the cost, a real saving whenever a long crane runway is involved or the construction of many new crane runways.

On outside cranes where frequent sanding of the rails is necessary during bad weather conditions, the elimination of the negative main feed conductor is not advocated. The build up of sand on the track will partially insulate the crane from the track (or negative feeder) resulting in shocks to the persons climbing on the crane, unless the main switch is opened.

The inherent flexibility of such a method of grounding is such that the maximum overall economy may be realized whenever installing mobile machinery, such as cranes, charging machines of every description, or industrial electric traction, and at the same time continue to wire all stationary electric drives as though the d-c systems were ungrounded.

In order to insure the maximum protection possible to motor equipment, particularly series wound crane and mill type motors, operating on a grounded negative system, the motor fields are connected on the negative side thereby reducing the potential to ground on same to a very low value. Likewise, a manually operated or magnetically operated reversing or non-reversing controller is so connected that the resistor accelerating train is connected to the positive side, the armature thereby being protected by some value of resistance during the starting period and thereby limiting the amount of current flowing to ground through a faulty or grounded armature.

With the application of grounded d-c systems, much consideration must be given to magnetic control circuits. The conventional circuits normally used with ungrounded circuits must be altered to insure the maximum protection afforded by the design and purpose of various control relays and equipment. Field failure relay coils should be connected close to the negative line so that a possible ground in the circuit will result in the desired operation of the relay. Similar connections to all other coils should be analyzed to insure that grounds will make contactors inoperative, and prevent faulty or unsafe operations of machinery.

Very briefly then, I would summarize the advantages of a grounded negative d-c distribution system somewhat as follows:

(a) Maximum overall economy may be realized when installing mobile machinery.
(b) Maximum protection to motor equipment particularly crane and mill type motors.
(c) In a system so installed, inspection and maintenance is facilitated, and to the advantage of greater flexibility may be added the advantage of dependability of apparatus.
(d) Minimum electrolysis.

I. N. TULL: Some years ago one of the plants using 500 volts had lots of failures and decided to change from an ungrounded system to a three wire grounded neutral system. They claimed a large reduction in failures attributable to the lower voltage to ground. In going to such a system however, plenty of balancer capacity has to be provided in order to maintain a stable neutral, otherwise a ground on either line would, in effect, form a short circuit between that line and neutral which would cause a rise in voltage between the other line and neutral.

The question of electrolysis is of interest to all of us and it is a dangerous thing to any underground conductor, be it lead cable sheath, metallic conduit, steam, air or water piping. An ampere flowing from lead can take away 75 pounds in a year. This means six pounds a month and it only takes a few ounces to make several holes in a sheath. A current density of five amperes per square foot can remove about twenty pounds of cast

iron in a year. With any leakage of current at all, it won't take long to put holes in pipes or sheaths.

I think undoubtedly there are some places where the system is grounded on one side or neutral when it is perfectly in order. I believe, so far as steel plants go, that an overhead type of installation would show better results than an underground system would, if grounded, due to the myriads of pipes and cables and the impossibility of keeping them free from electrolysis.

In mines, 250 volts is practically universally used, with the negative grounded, and very seldom any other return than the rail. Per hundred motors installed, more failures are obtained under grounded negative conditions than ungrounded and the damage done at point of failure is usually much more severe than when the system is ungrounded.

There are a good many cases where a ground develops on a motor or cable when it is possible to keep on operating until convenient to remedy or change without an interruption in operation; and our main job is to keep the wheels turning without delays. Accordingly, we should use that system which will have the best chance of continuous operations.

I think the authors of the paper recognized the fact that each case is a study in itself and I agree with that conception. There can't be any general rule laid down, any more than any general rule for a-c transmission and distribution, grounded Y or isolated delta.

H. R. MIDDLEBROOK: Mr. Fountain's paper opens up a controversial subject, and in my numerous years of experience with d-c systems, I have never given the aspect of grounded systems any particular consideration. We, as you probably know, have a rather extensive d-c installation in our steel works, and about the best we can hope to attain is a compromise condition, which Mr. Black spoke about. We try to keep the grounds off the system. Sometimes we do to a certain extent, but most of the time we have the ground either one side or the other. But we do find one thing that probably all of you have noticed. That is, in the event of an ungrounded system, if a ground takes either one side of the line or the other, you are apt to lose a few motors, which fact may be interpreted by the proponents of the grounded systems as an argument for the grounded system. However, with the stress under which we are laboring at the present time in all steel mills, I doubt if the operating management would care very much for the outages which would certainly happen on the grounded system.

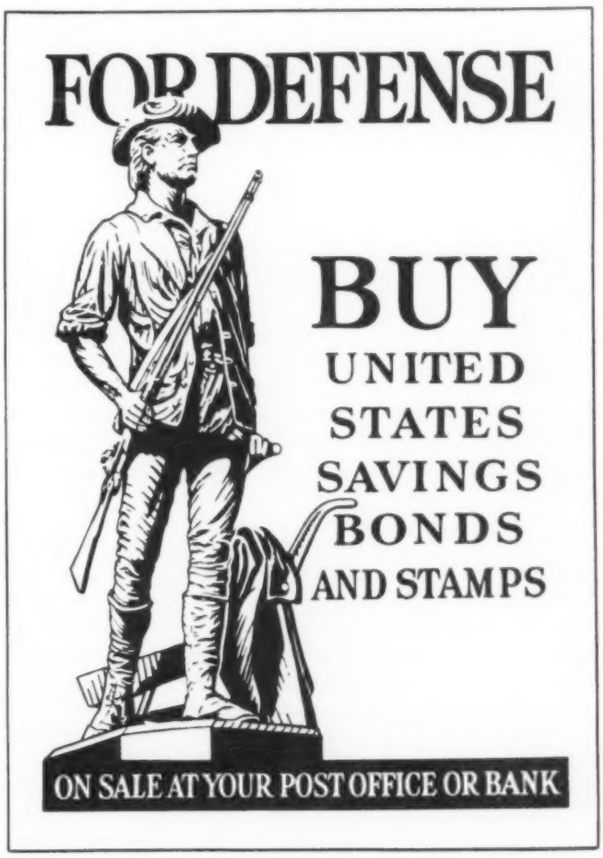
Often we find that we can run for some time with a first class ground either one side of the system or the other without causing any interruption to service.

There is one point that was not stressed enough in the paper, and that is in regard to the possible cable sheaths. The water pipe was spoken of, and structural work; but I think that the cable sheath is the dangerous part in the plant where the underground system is rather extensive. We have experience on that score. Mr. Perry brought up the question of whether or not it would aid materially in the reduction of installation costs. In the event that one has to run copper the equivalent in size to the normal conductor that you would have on the negative side of the line, which would proably be grounded, it seems to me that the economy is not any gain at all, because the copper would be the same. Of course, as far as relay and the switch are concerned, that would immensely simplify things.

H. A. TRAVERS: It has been very interesting to hear the discussion. My reaction is that we have marched very far. Mr. Black said that you are all interested in overall economy. It seems rather obvious, at least to me, that certain plants find it most desirable in their distribution circuit to operate with one polarity grounded. Bear in mind, however, that in doing so, you must be sure that your grounded return is equal or even better than the ungrounded circuit in size, so as to give the most direct path back to the source of power.

Nothing has been said in the discussion about the higher voltage d-c systems. Naturally, I think it is rather clear that we are more or less in agreement that where expensive equipment is involved, and where it is well housed, and not subject to the ills that confront the general distribution circuit, it probably is better off ungrounded.

Buy Defense Stamps and lick the other side.



STOKER APPLICATION for Combination Firing of Boilers

By Otto de Lorenzi

ASSISTANT GENERAL SALES MANAGER

COMBUSTION ENGINEERING CO., INC.

New York, New York

Presented at A. I. S. E. SPRING CONFERENCE, YOUNGSTOWN, OHIO

▲ COKE breeze and blast furnace gas, at one time, were regarded as necessary waste products to the steel manufacturing process. Today, however, they are usefully employed to supply a large portion of the power that goes into finished steel products. This change from "waste" to "use" has been occasioned by the gradual development of combustion equipment and furnace design. As a result, the efficiency of steam generation by these fuels has been increased to a point where it is practically on a par with the so-called more desirable fuels. The difference in cost of steam when generated from purchased fuel or from these otherwise waste products, is no insignificant item in the nation's steel bill.

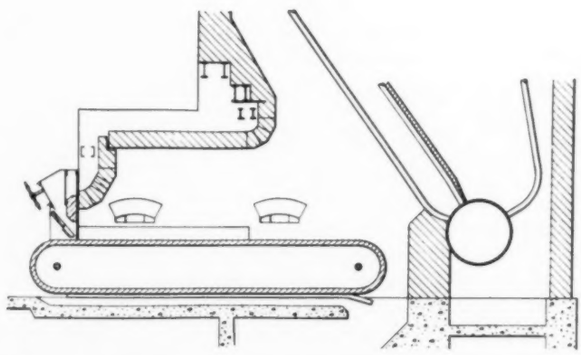
Coke breeze and blast furnace gas are quite unlike in physical characteristics. One is a solid and the other a gas. Breeze is a concentrated fuel having a relatively high Btu content, while blast furnace gas is quite lean and has a low heat content. Practical developments in handling breeze have established the traveling grate stoker as the best method for securing its most economical combustion, while gas is handled with a burner. Each fuel has certain inherent disadvantages with respect to ignition in the furnace, the breeze because of its low volatile matter content, and the gas because of its leanness. The ignition difficulties, however, have been completely surmounted, and are no longer a serious drawback.

COKE BREEZE

In the manufacture of metallurgical coke, as it is handled and quenched, small pieces are broken off which are not suitable for blast furnace use. As a rule, coke breeze is that portion of the breakage which will pass through a ¾ in. round hole screen. This then is the fuel available for stokers. With certain furnace designs, it is possible to obtain a higher operating efficiency when the fuel will screen through ¼ or ⅜ in. diameter holes, as compared with the commonly specified ¾ in. It is indeed fortunate that as actually made there is usually a sufficient proportion of fines to give ample surface exposure and thus aid ignition. The fines, for best results, should be not less than 15 per cent or more than 30 per cent of the fuel weight. To secure consistent results from a stoker, it is necessary to provide a uniform mixture to the grate. The design, which minimizes segregation of the fuel in bunkers, downspouts and stoker hopper, will pay handsome returns on the engineering efforts expended to produce it.

Attempts have been made to burn coke breeze on every available type of stoker. The practical, as well as economic results, have left the field almost exclusively to the forced draft traveling grate stoker. The original furnace designs were of the familiar dutch oven construction using a horizontal arch over the front of the stoker. A setting of this general type is shown in Figure 1. With these it is possible to operate continu-

Figure 1—Early dutch oven type furnace for burning coke breeze.



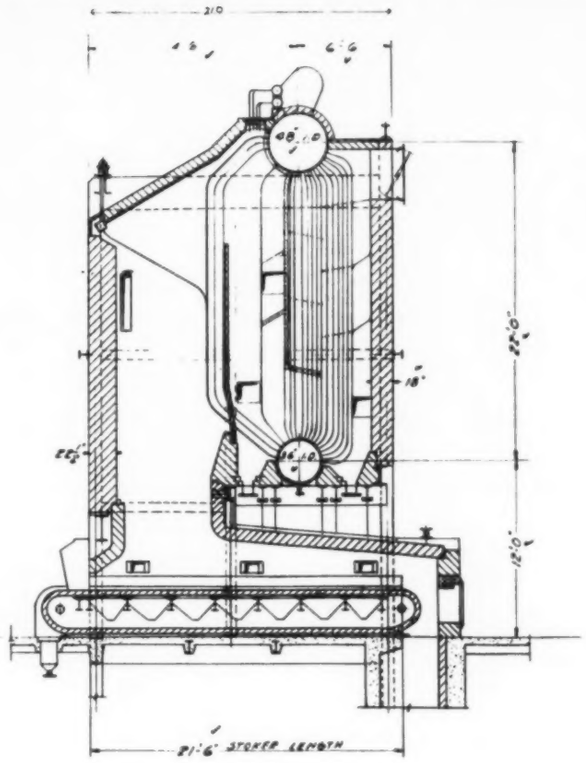
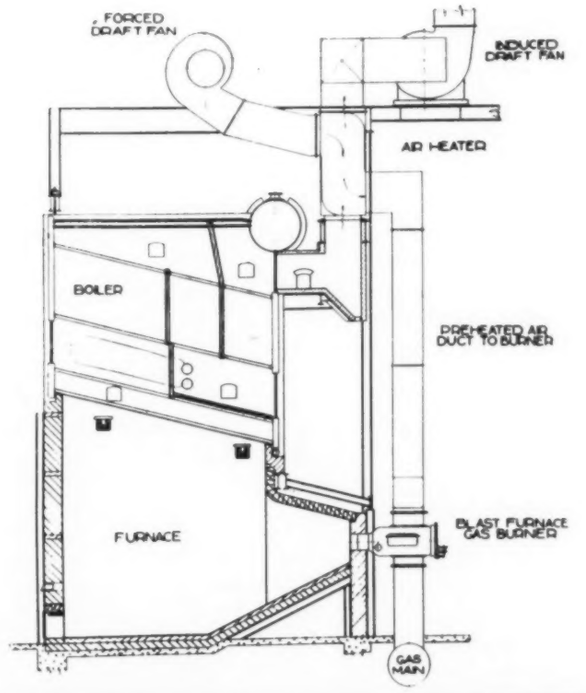


Figure 2—Recently designed "rear arch" type furnace.

▲

Figure 4—Semi-turbulent burner used with relatively large furnace.



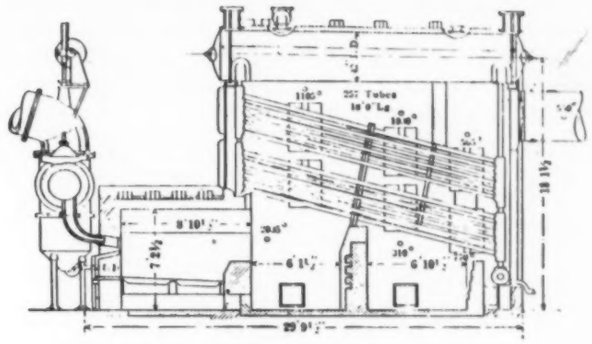


Figure 3—This installation was considered to have a large furnace (1915).

ously at combustion rates of 30 lb per square foot per hour and combined efficiency of seventy per cent under ordinary conditions.

With the recently designed "rear arch" type of furnace, Figure 2, somewhat higher efficiencies and combustion rates are possible. The reason is that full advantage is taken of the furnace volume provided. Furthermore, the arrangement of arches makes it possible to increase turbulence in the furnace gas streams and insure complete combustion and uniform mixture of the products of combustion as they enter the boiler passes. In these furnaces improved results may often be obtained by using $\frac{3}{8}$ or $\frac{1}{4}$ in. breeze.

BLAST FURNACE GAS

Blast furnace gas is available to the boiler house as a fuel. The amount of dust carried in the gas will depend on the cleaning methods used. It has been found profitable, in most instances, to wash the gas even though there is a loss in sensible heat and a heavy loading of water vapor. Furnace and burner designs are determined by the cleanliness of the available gas.

Burners for blast furnace gas have passed through many stages of development. The principal object is to obtain a design that assures intimate mixture of the gas with the combustion air. Recently it has been found, by continuing this mixing action, and providing turbulence in the furnace, that the combustion process is accelerated. This results in higher permissable liberation rates in a given furnace. Furthermore, by the use of preheated air, we can speed up and fully stabilize the ignition of the incoming fuel stream, even though water cooled furnaces are provided.

About 1915 the installation shown in Figure 3 was considered to have a large furnace. The performance was considered quite exceptional. Obviously, the type of burner and furnace are such that there is almost total lack of turbulence. Long flames, high exit gas temperature, and low efficiency resulted whenever it was necessary to carry even relatively high overloads.

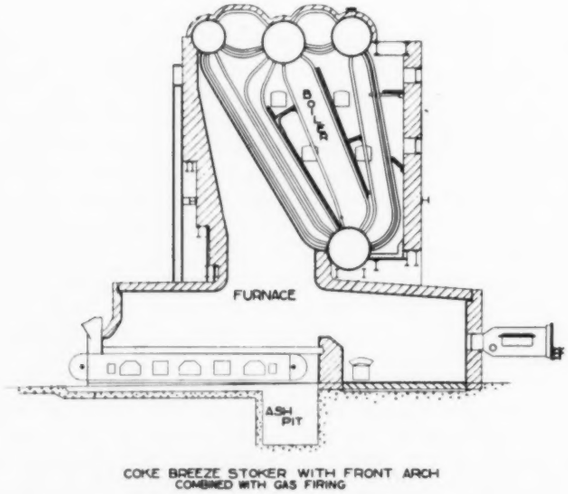
The next step came with the development of a semi-turbulent burner and the use of relatively large combustion chambers. Efficiency was increased and overall performance was more reliable. This type of furnace is illustrated in Figure 4. Finally the use of the fully water cooled furnace and the adaptation of tangential firing to blast furnace gas units made it possible to develop high steam outputs with normal furnace widths.

COMBINATION FIRING BLAST FURNACE GAS AND COKE BREEZE

There are many installations for coke breeze firing and for gas burning. In a blast furnace plant, however, there is a non-uniform production of these two available fuels. Since coke breeze is a solid it may be stored, while gas must be burned as it is made or wasted to the atmosphere. If separate gas and coke breeze fired units are installed, then the plant must be able to handle the maximum gas quantity available at any one time. In addition, there must be sufficient capacity in the coke breeze fired units to handle the maximum demand that may exist when there is no gas available. By a combination of furnace designs, it is possible to burn either one fuel or the other, or both simultaneously in sufficient amounts to develop the full rated capacity of the unit. This, of course, materially reduces the boiler plant investment. The development of combination furnaces has progressed so that the newer designs are giving trouble-free operation with capacities that in most cases exceed guarantees.

In designing a combination furnace, there are a number of possible groupings of stoker, burner, furnace and boiler. The stoker and burner may both be below the level of the boiler so that the gas travel from each is upward. It is possible to locate the burner on a level well above the stokers. It does not seem practical to locate the burners beneath the stoker or below the level of the stoker. No matter how the combination is designed, it is necessary to shield either piece of combustion equipment when the other is in service. It is advisable to design the setting for the minimum practical amount of brickwork. Floor space has a different value in various plants. Limitation of head room may compel a design variation which would not be considered if there were additional vertical space available.

Figure 5—One of the early types with gas ignition chamber in rear.



COKE BREEZE STOKER WITH FRONT ARCH COMBINED WITH GAS FIRING

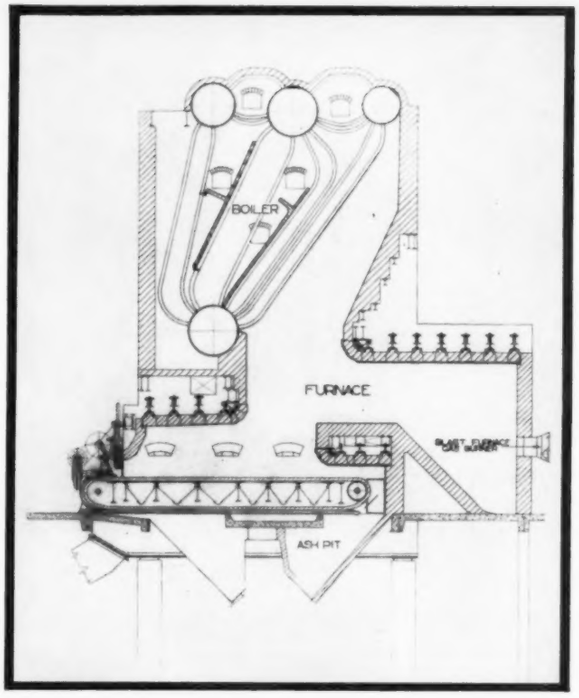


Figure 6—Another early type with front ignition chamber and small rear arch in addition to long front arch over stoker.

The design shown in Figure 5 is one of the early types. It consists of a traveling grate stoker with blast furnace gas burners under a bent tube boiler. The appearance indicates that an effort was made to dispose of the available blast furnace gas by burning it in an inadequate combustion chamber, and simply accept the low efficiency of heat conversion that exists with this design. The stoker is set under the front of the boiler and is provided with the conventional dutch oven construction with front arch. The gas burner is located under the rear of the boiler and has its own ignition chamber in rear of the stoker bridge wall. This wall serves to separate the two primary combustion chambers, and at the same time, to partly shield each piece of apparatus. There is a fair amount of flame travel in the upper combustion chamber and the control is all on the firing floor. This furnace has been in operation for a number of years, and is actually burning coke breeze as well as blast furnace gas.

Another arrangement, similar to the foregoing, is shown in Figure 6. The positions of stoker and gas

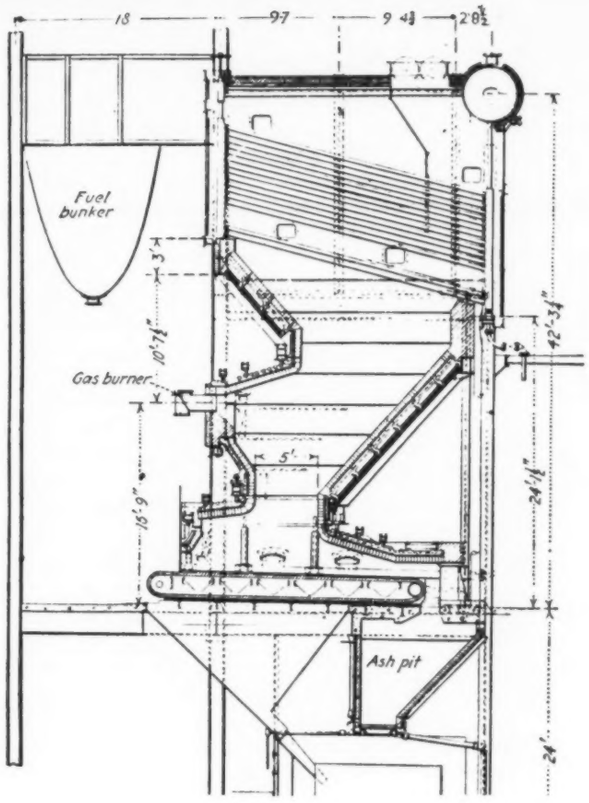
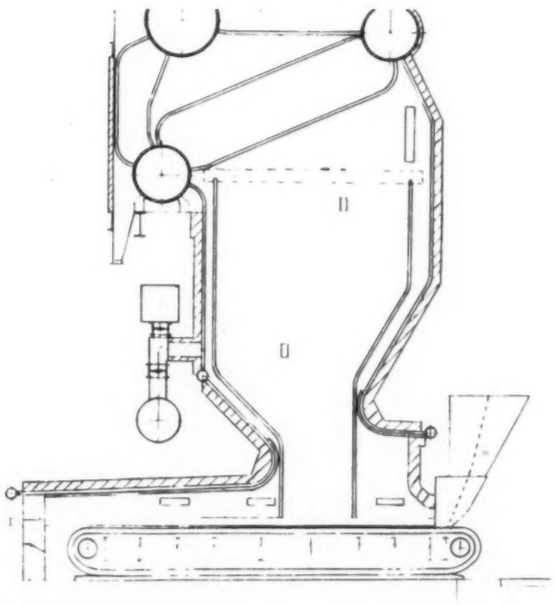


Figure 7—Combination front and rear arch setting, with gas burner placed well above stoker requiring considerable head room.

▲

Figure 8—Simplified setting with gas burners located in large upper combustion chamber.

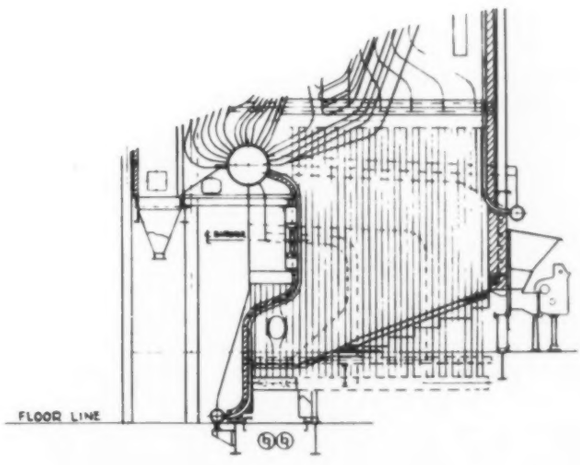


burner are reversed and there is a small rear arch in addition to the long front arch. The rear is actually a short horizontal extension of the bridge wall rather than the more advance type indicated in Figure 2. With this design the volume of the secondary combustion chamber is smaller, but the flame travel is quite long.

The next design step is one in which the gas burner is placed well above the stoker. A combination rear and front arch are provided for burning the coke breeze. It will be noted in Figure 7 that this type of unit requires considerable head room for installation. However, due to the adequate furnace volume provided, excellent operating results are obtainable. It has been possible to burn breeze and gas simultaneously over a wide range of ratings with very little excess air. The principal objection to this design is the unusually large amount of refractory construction required.

In contrast to the foregoing, note the simplified construction of the unit in Figure 8. In this case a full rear arch type of furnace is provided over the stokers. The solid fuel consists of either coke breeze or anthracite No. 4 buckwheat. A division plate in the stoker makes it possible to burn these two fuels either separately or simultaneously, as may be required. The gas burner is located in a large upper combustion chamber, and is of sufficient size to develop full output on gas alone. Refractory maintenance and accumulation of slag deposits are minimized by the use of water cooled surfaces in certain areas of the furnace. There are three units of this type in the plant. One of them is usually operated on a combination of coke breeze and anthracite coal. The other two units take all of the available gas, and in addition, burn as much of the solid fuel as may be necessary to meet the steam demands. The operation has been most successful and all guarantees as to performance have been met or exceeded. Through the courtesy of this customer it was possible for us to

Figure 9—Multiple-retort stoker in combination with gas firing through rear wall.



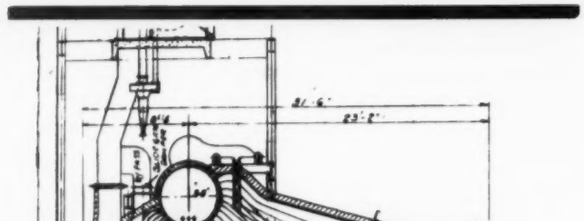


Figure 10—"Spreader" stoker in combination with gas firing through front wall.

take colored motion pictures of the actual furnace operating conditions.

There remain two other types of stokers to be considered for combination firing. In Figure 9 is shown a multiple retort machine with gas firing through the rear furnace wall. In this case the solid fuel is bituminous coal and any type of gas may be used if suitable burners and furnace volume are provided.

The one remaining stoker design to be considered is the "spreader". Relatively few installations for burning coke breeze have been made with this type. However, it can be satisfactorily handled provided the sizing is correct and the combustion rates are maintained at a reasonably low level. In Figure 10 is shown a furnace for combination burning of gaseous and solid fuels. It will be noted that furnace volumes with this stoker are quite liberal because a portion of the fuel is burned in suspension. However, care must be exercised in locating the gas burners so as to provide sufficient flame travel before the boiler surfaces are reached.

CONCLUSION

In conclusion we may say that it is entirely possible to design combination furnaces for burning solid fuel on the stoker grates simultaneously with gaseous fuels. As a result, wider flexibility and operation with the available fuel, to the full rated capacity of the unit, are possible. Gas is burned in the amount available in the mains and the deficiency in steam output is made up by the quantity of storeable fuel used. A number of designs are available which may be fitted into existing plant limitations. However, where possible, a design similar to the one shown in Figure 8 should be used.

The use of such heat recovery devices as economizers and air heaters is determined by an economic study based on load factor and fuel value. These will change for each plant, and a careful study must be made to decide whether or not their installation is justified.

DISCUSSION

PRESENTED BY

L. F. COFFIN, *Superintendent*, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

OTTO de LORENZI, *Assistant General Sales Manager*, Combustion Engineering Company, Inc., New York, New York

E. W. TREXLER, *Mechanical Superintendent*, Bethlehem Steel Company, Johnstown, Pennsylvania

L. A. DEESZ, *Combustion Engineer*, Republic Steel Corporation, Youngstown, Ohio

O. P. BURR, *Assistant Superintendent*, Steam Department, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

W. P. HILL, *Steam Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland

L. F. COFFIN: In the case of combined blast furnace gas and coke breeze installation and assuming that the boiler is operating at full rating on 50 per cent blast furnace gas and 50 per cent breeze, will the pick-up on breeze firing in case of sudden total failure of the blast furnace gas avoid excessive drop in steam pressure? If the combined unit cannot be operated on straight blast furnace gas, what is the minimum amount of breeze that has to be burned? It would be interesting to have figures on efficiencies lower than full load rating. Will this modern type of furnace and stocker burn coarser breeze as efficiently as it will the finer breeze?"

OTTO DE LORENZI: In the first place, with regard to the question of pick-up with the rear arch furnace. The fuel bed is usually quite long, running, say, 50 per cent of the stoker length. The grate speed may be 20 or 25 feet an hour. You have a sudden failure of gas. It is necessary to step the stoker up to its maximum speed.

In the installation described the maximum speed was 125 feet an hour. I think that 100 feet an hour will carry the peak load. Now, assuming that you are running at normal, say, 100,000 pounds an hour, and you have a possibility of 150,000 pounds per hour peak load, with a failure of gas, you simply open up the air controls under all sections of the grate. This is, you increase the burning rate to stop the sliding off of the steam pressure. Simultaneously the stoker is stepped up to full speed to catch the falling pressure as quickly as possible.

There will be some drop, perhaps ten pounds. As I recall, there were times in the foregoing plant when, practically without warning, the gas went off entirely. Under these conditions the steam load increased, and there were no bad valleys in steam pressure curve.

In regard to the minimum amount of breeze that you can burn, I would say that it runs about two pounds per square foot per hour. The blast furnace gas is burned in the upper furnace, and practically all of the stoker is shielded, so there is very little area that is exposed to full furnace heat. Very little air is used under the stoker.

Now the third question on the fineness of the breeze. The normal specification for size is three-quarter inch round hole screen. All the breeze is supposed to go through this screen, and yet should have from 15 per cent to 30 per cent fines. These are required to fill up the voids and give quick penetration of the ignition. Now, by dropping off to three-eighths or quarter-inch breeze, you increase the surface and also the amount of fines blown off the grate. On the other hand, if you use fuel that runs through an inch or an inch and a half screen, the surface of the fuel exposed is reduced. It will ignite and burn more slowly. The grate speed is lower; and generally the fuel bed, instead of being four inches, may be as thick as eight inches. The efficiency will be somewhat lower as it is necessary to use more excess air.

With this coarse breeze you do have somewhat of a larger carbon in ash pit loss, but the amount going up the stack is less and somewhat compensates for the increased loss in the ash pit. That is presupposing that with the small size breeze you return to the furnace the siftings that are accumulated throughout the boiler.

E. W. TREXLER: In most coke stokers it has been the practice to use an auxiliary fuel, such as gas or liquid fuel. Is there any intention of having such an auxiliary fuel in addition to blast furnace gas and coke breeze in a combination fired boiler of the type under discussion?

OTTO DE LORENZI: I don't know. If it is just for the question of maintaining ignition, I would say no. But if it is a question of having these fuels available in the event of a failure of any of the other fuels, it makes no difference. The furnace is designed for blast furnace gas. In it you can handle a liquid or gaseous fuel. You would probably require special type of burner for the other fuels—but all of these burners may be located in the upper furnace without any difficulty. You could operate on any combination. Three or even five fuels make little difference in a furnace of this type.

L. A. DEESZ: With the high speed and velocity that you have obtained under your arches, say, of 60 to 75 feet a second, and with the accompanying pick-up that you will get, of course, with those high velocities in carrying over larger particles, what effect does that have on the abrasion of the arches? How long do these arches last subjected to these high speed velocities?

OTTO DE LORENZI: There may be plenty of incandescent barnacles on the arches, and yet there may be hardly a case of a solid particle striking the arch. The cushion of air that comes from the ash pit forms a layer in the upper zone of the furnace. There is little or no striking of the solid particles against the arch. They turn quickly and go horizontally forward rather than turning up. I don't know of any case where we have had a scouring effect—that is, the loss of a rear arch due to scouring effect. There have been cases where you may burn them out, if the furnace is operated at a pressure. This is different than when running under normal conditions with a negative pressure in the furnace.

L. A. DEESZ: Where do you lose the velocity so you do not carry your fines all over the neighborhood and make a public nuisance of it in the plant vicinity?

OTTO DE LORENZI: Well, sometimes you do make a public nuisance of the stack discharge. It depends on the operation and the amount of fines initially in the fuel. If the fuel contains a high percentage of fines, and many of them contain more than is desirable, and at times it is necessary to get rid of pit breeze by mixing it in with the normal breeze. You then have a fuel that may run 50 per cent fines. It can be handled on the stoker, but the stack discharge will be high.

The guarantees made are based on better breeze. But if you must get rid of the undersize fuel, the stoker is a good place to do it. However, the stack is a distributor. Unless you have some device to keep the fines from reaching the stack, they will be distributed in the neighborhood of the plant.

The velocity under the rear arch is 50 to 60 feet per second. In the upper chamber it drops to about 30 feet. This decrease in velocity will cause some fines to drop back into the furnace. Most of your modern boilers have sharp turns in the passes and pockets below them for catching a fair percentage of the carry-over. However, you will find that an appreciable percentage does go out of the stack even with these precautions.

O. P. BURR: I don't know that I have anything to add to the discussion here today, relative to burning coke breeze on chain grate stokers. We try to do a pretty good job of burning it on underfeed stokers, and our problem there is to avoid getting an excessive amount of fines. These fines blow up into the chimneys and we lose considerable combustible that way. Also, on the control system, which is designed for coal, when we are operating on automatic control, our fuel beds build up to an excessive thickness, and we are bothered with too high a combustible in the ash.

Coke breeze, which the speaker has defined here as being suitable for burning under boilers on chain grates, would not present much of a problem on an underfeed stoker such as we have been using. Where our fines would be limited between 15 and 30 per cent, I do not see that there would be any special difficulty in burning a fifty-fifty mixture of coal and coke breeze on an underfeed stoker. The abrasion on stoker parts—rams and ram boxes, is, of course, much worse with coke breeze than coal.

Another factor is that with the high ash in the coke breeze; boiler efficiency is bound to drop off. As a rough figure, I would say that stepping up your total fuel percentage to 40 per cent of coke breeze will give you an approximate drop in efficiency of 15 per cent. If you can get 70 per cent on coal which the furnace is

designed for, with the coke breeze mixture up to 35 per cent, of which at least two-third are fines, your efficiency will go down to about fifty-five per cent.

W. P. Hill: In many cases, you have a varying load on different fuels, and it is hard to maintain the proper superheat temperature. I was wondering why they didn't use convection and radiant superheaters both, to balance the temperature.

Otto De Lorenzi: I think you will find with blast furnace gas and also solid fuels that it is quite difficult to use a combination convection and radiant superheater to effect superheat control. The best method of doing this is to use a by-pass damper control. With this arrangement there must be provided sufficient superheating surface to give the correct temperature with the fuel that has the least gas weight. Then part of the superheating surface is by-passed when you have a fuel that has a greater gas weight and a resulting tendency to give a higher steam temperature.

Of course, there is another way this can be done: by the use of a desuperheater. That is much more positive than with the use of a combination convection and radiant superheater.

There is one thing in connection with these pictures I should like to mention. There seems to be a misunderstanding that it is necessary to burn a combination fuel on chain grate stokers. That is not the case. In this plant it is necessary because there is not enough breeze. It is unusual that we must simultaneously burn two fuels on the stoker. We burn coke breeze, anthracite, free-burning bituminous coals, or lignites, depending on the conditions without using any auxiliary fuel to insure or maintain ignition.

With this combination shown, we do not have a fall-off in efficiency due to mixing. In other words, it doesn't make any difference that you have a mixture of anthracite and coke breeze. You get an averaging of two efficiencies. The coke breeze may give you 76 or 78 per cent, and the river coal 70 per cent. If the two are burned in a fifty-fifty mixture, you get the average efficiency of approximately 74 per cent.

In this particular operation there is no question of trying to mix two fuels uniformly. That is difficult and a real problem. In 1921 I ran a test in Milwaukee in which we burned a mixture of coke breeze and bituminous coal. The coal and coke were mixed four times before they arrived on the grate. Even then there was segregation. An efficiency of 68 per cent at a combustion rate of 40 pounds, with boiler operating at 200 per cent rating, was obtained. A front arch type of furnace with traveling grate stoker was used.

A. I. S. E. Annual Spring Conference

HAMILTON, ONTARIO, CANADA, APRIL 27, 28 - 1942

Royal Connaught Hotel

MONDAY, APRIL 27

2:00 P.M.—Inspection trip, Dominion Foundries and Steel, Ltd.
6:30 P.M.—Dinner
8:00 P.M.—Technical Session
"Flat Rolled Production at Dominion Foundries and Steel, Ltd." by D. O. Davis, Superintendent of Maintenance, Dominion Foundries and Steel, Ltd., Hamilton, Ontario
"Plate Mill Drives and Power Requirements", by C. J. Porter, Electrical Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario; C. A. Price, Chief Engineer, Canadian Westinghouse Company, Ltd., Hamilton, Ontario; and A. F. Kenyon, Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

TUESDAY, APRIL 28

9:00 A.M.—Technical Session
"Fuel Rate Control Systems for Regenerative Furnaces", by J. R. Green, Brown Instrument Company, Pittsburgh, Pennsylvania
"Developments in Non-Ferrous Bearing Metals", by H. A. White, National Bearing Metal Company, Pittsburgh, Pennsylvania
"Steel Plant Lighting in Wartime", by J. P. Ditchman, General Electric Company, Nela Park, Cleveland, Ohio
2:00 P.M.—Inspection trip, Steel Company of Canada, Ltd.

BLACKOUT LIGHTING

A discussion of British and American Practice

By Davis H. Tuck, Electrical Engineer

HOLOPHANE COMPANY, INC., New York, N. Y.

▲ SOME time ago while working with an engineer in New York writing up a specification for blackout lighting for one of our island bases, we found an article in an Australian technical publication calling for a black-out illumination of 0.002 ft-c for marine docks. The British A.R.P. specification for blackout street lighting calls for 0.0002 ft-c. We thought there might be a misprint in the Australian article but the value was repeated several times so I wrote to Dr. S. English of London, knowing that he had helped with the British specifications, asking him if more blackout light was really allowable for docks than streets in view of the relative greater importance of docks. Dr. English's answer to my inquiry is most instructive and I reproduce it here thinking that it will be of interest because it contains so much background and fundamental data which furnish the basis of our efforts in blackout lighting:

Dear Sirs:

We have received your letter of the 3rd instant pointing out an apparent anomoly regarding the intensities of black-out illuminations permitted in docks as compared with the corresponding illumination permitted on roadways.

The .002 ft-c figure for docks, etc. was determined by a committee which was working for a year or more before war broke out. In their experiments they found that this value was necessary in order to permit of rough work being done: by this, I mean the moving of parcels and packages, etc. A similar degree of illumination was permitted on railway platforms where again similar work had to be done and people had to be able to see their way about reasonably well and to avoid falling off the edge of platforms.

When it came to the question of street lighting at a much later date, we started our experiments at the same .002 ft-c level and found that a roadway (concrete surface) lit to this level could be picked out quite easily by aeroplanes flying at 10,000 feet. We gradually decreased the illumination until a roadway was invisible to an aeroplane flying 3,000 feet. This level was found to be .0002 ft-c. In fixing this level the Air Ministry naturally had a big say, since they were responsible for protecting the country against raiders and therefore, were keen on towns being invisible from the air.

At one time an influential move was underway to increase the light permitted in streets: in any case, in the central shopping areas of towns. Experiments were made with this in view, but it was soon found that even a restricted area illuminated to the level the committee had in mind was so easily visible from the air that the idea had to be dropped. This roadway illumination of .0002 ft-c was found to be helpful in permitting people whose eyes were dark adapted to distinguish large objects. For instance, they can fairly easily see piles of sandbags that may be littered about the pavement: they can also see other people approaching sufficiently well to avoid collisions, so that, although this illumination is not enough to perform even rough work by, it is just sufficient to be of some little service on the road.

Regarding the black-out requirements inside industrial plants, we have now a compulsory regulation that all factories which are engaged on work for the Ministry of Supply must have a minimum illumination of 6 ft-c through-out the whole interior of the factory. Such illumination is quite independent of higher values that may be necessary for the work in hand. Despite these distinctly higher figures than were common in pre-war days, factories are under compulsion not to permit any light to be emitted through apertures of any kind during blackout hours. Various schemes were tried including the rather attractive (theoretically) complementary lighting scheme, but this was turned down, since even with the best possible combination of colours some light was emitted, and the regulations are quite definite that no light must be emitted.

As regards yards, roads, etc., round industrial plants,

the regulations vary somewhat according to the nature of the work being done. In some plants where work must be carried on in open sheds or shops that have sides that emit light, the illumination in such cases must be cut down to the value of 0.2 ft-c but permission to use this intensity is only given after careful examination of the requirements of the job and on condition that all lights will be put out immediately a warning is given that a raid may be expected. Some other industrial plants are permitted to have the same illumination as docks, railway goods yards, etc., that is, .002 ft-c and in some cases this illumination may be kept on even when a raid is in progress, since it is regarded that such work must proceed if it is at all possible.

The roadways and fences in industrial yards may have the same scheme of lighting as public roadways providing that approval is first obtained for the installation of such lighting.

These various requirements regarding lighting were necessarily worked out in a hurry and we are aware of the fact that they are not one hundred per cent perfect. Still, in view of the conditions, they are not working at all badly.

If there are other points on which you would like still further data, do not hesitate to ask again.

Yours faithfully,

HOLOPHANE LIMITED

S. ENGLISH, *Director*

For purposes of easy visualization of the footcandle values involved 0.0002 ft-c is approximately equivalent to star light on a clear moonless night; 0.02 is approximately equivalent to full moonlight on a clear night, and 0.002 is either 1/10 full moon light or 10 times starlight.

It would seem that the British specifications in effect is exactly the same as the instructions sent out in the United States on January 12, 1942 by the War Department Adjutant General's office "Intensity of any light used (blackout) shall be minimum compatible with purpose for which used". In other words, we know from British experience that 0.0002 ft-c is fairly safe but considerable latitude up is necessary to take care of special locations. We can assume, therefore, that the lower and upper limits of blackout footcandles will be approximately 0.0002 and 0.002 ft-c.

The subject of color of light for blackout has received considerable attention. It would appear that color was first introduced because colored glass offered a convenient and inexpensive means of absorbing the light down to required low values and that to justify the use of colored glass as an absorbing medium scientific facts were advanced to mask the real reason for the use of colored glass. For instance, it was claimed that blue light could not be seen as far as white light or red of the same candlepower and on this basis blue blackout light has been in general use in the past. It has been demonstrated however that of all colors, blue is the poorest to use for blackout. U. S. War Department engineers have shown that blue light is more easily observed from the air and is less helpful to ground activities than any other color. Deep red light is of all colors less easily observed from the air and gives better vision on the ground. Red has an additional advantage of facilitating dark adaptation which means that when the regular light is turned out and the blackout light turned on, the eye adjusts to the lower level quicker with redlight. It was found, however, that red light has little effect on the part of the eye which detects movement of pedestrians, autos, etc., which is a definite disadvantage. Also it has been pointed out that red light might call attention to blackout areas by their distinctive color and thereby defeat its purpose. The War Department recommends a compromise of using white light which allows quick adaptation, good vision of detail and movement and is not easily seen from the sky and does not, by peculiar color, call attention to important blackout areas. White light is also used in England and is so specified by A.R.P. Fortunately the small wattage incandescent lamp gives white light on the reddish side and is particularly well suited for blackout purposes. Our blackout efforts are based on the possibility of temporary blackout which might result from nuisance or hit-run bombing lasting a few minutes instead of permanent blackout as England has been forced to adopt. A few of our newer plants are windowless and a few others of extreme importance have been permanently blacked out, by obscuring windows and doors so that production will not be seriously interrupted. In the main however, we will temporarily suspend operation during a blackout period and provide only sufficient light for the workers to see how to move about in the plant interior or exterior. There are, of course, certain industrial processes and services which by their nature must continue, such as heats and chemical sequences and these must be dealt with as an exception to the general rule. Among such classes are TNT works, generating stations, open hearth furnaces, etc.

Some of our larger cities have already established blackout procedure and have passed ordnances which give them the authority to enforce blackout precautions.

There are already several types of blackout lights available as complete equipment intended to be used in place of the regular productive lighting system. These units are in general of three classes: (a) A deep bowl hood with a small incandescent lamp covered with a dark blue or red glass, the glass being set up in the hood so that no light is emitted above the horizontal; (b) A deep bowl hood with a small neon or argon lamp placed well up in the hood; (c) the English type of blackout light consisting of a metal hood, a shallow refractor, a small lamp and a horizontal shield. The English type unit has the advantage of a wide distribution of light (maximum candlepower at 75 degrees) so that they can be spaced on wide centers (usually 160 ft) which in turn makes for an economical installation. They give white light. Blackout lights are operated on the regular multiple circuit but it is advisable to have an automatic throw over to an emergency source of power such as a gasoline generator or a storage battery.

In locating blackout lights care should be taken that excess light is not spilled on nearby walls, columns, etc., as due to their nearness they may become unduly bright.

No blackout lights have as yet been officially approved or rated by any branch of the government.

Design of Lubricants for MECHANIZED LUBRICATION

By F. E. Rosenstiehl

SUPERVISOR, TECHNICAL SERVICE

THE TEXAS COMPANY

New York, N. Y.

Presented before A. I. S. E.

PHILADELPHIA DISTRICT SECTION

▲ THIS paper is intended to describe some of the behind-the-scenes activities in the oil industry which have resulted in the development of improved lubricants to meet the exacting requirements of modern steel mill equipment. At one time or another, many have wondered just how the petroleum industry develops lubricants to meet the requirements of newly designed equipment. There is a long story behind the development of every new lubricant, which starts with the oil supplier endeavoring to cooperate with the equipment manufacturer, almost from the time a new piece of equipment is laid out on the drawing board.

Having gained this knowledge of design, as well as a thorough understanding of the operating conditions to which the lubricant will be subjected, it is then necessary to go into the laboratory and the refinery, and develop a lubricant which will have those characteristics which have been previously determined to be necessary for the satisfactory operation of the equipment involved.

Judging from some of the questions which are raised when operating men discuss lubricants, apparently many consider that there is something mysterious in connection with this subject. To correct this impression the following three examples are given to show how new lubricants have been developed to take care of specific steel mill requirements.

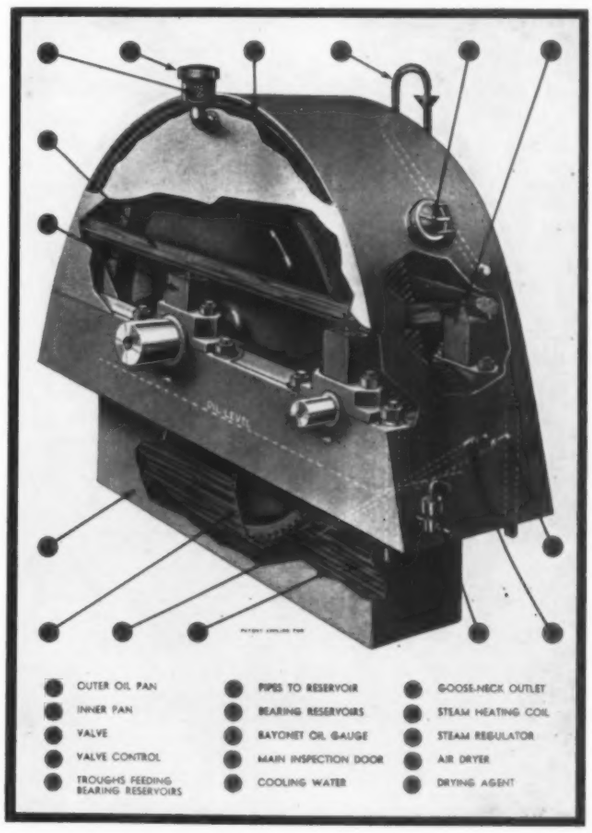
GEAR LUBRICANTS

During the past few years, the use of extreme pressure (E.P.) gear lubricants has increased greatly. We may well spend some time considering the reason for the use of such type lubricants, how they are made and when and where they should be used.

Their development was due primarily to the unsatisfactory results obtained with straight mineral oils when used for the lubrication of high-speed, heavy-duty enclosed gear sets, although straight mineral oils had previously proved satisfactory in slower speed and lighter load service. It is understood, of course, that when I refer to straight mineral oil I mean a pure petroleum oil, containing no soaps or other added materials, which may be added for any number of reasons.

When changes in operation or production requirements were made, resulting in increased speeds, loads,

Figure 1—A typical bath lubricated gear set. The same lubricant is used for gears and bearings.



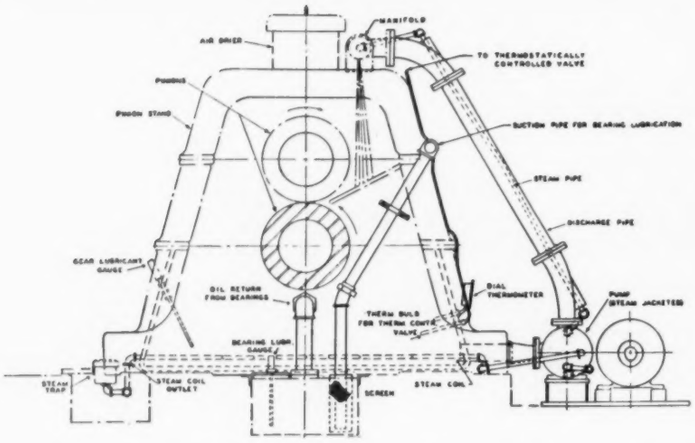


Figure 2—Diagrammatic sketch showing a pressure lubricated gear set.

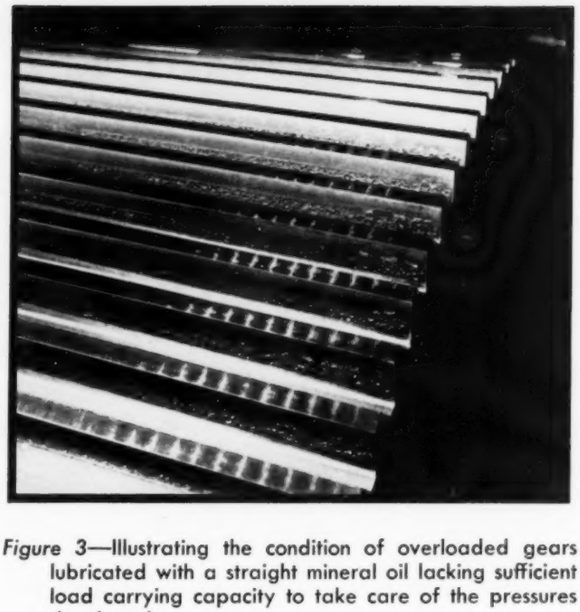
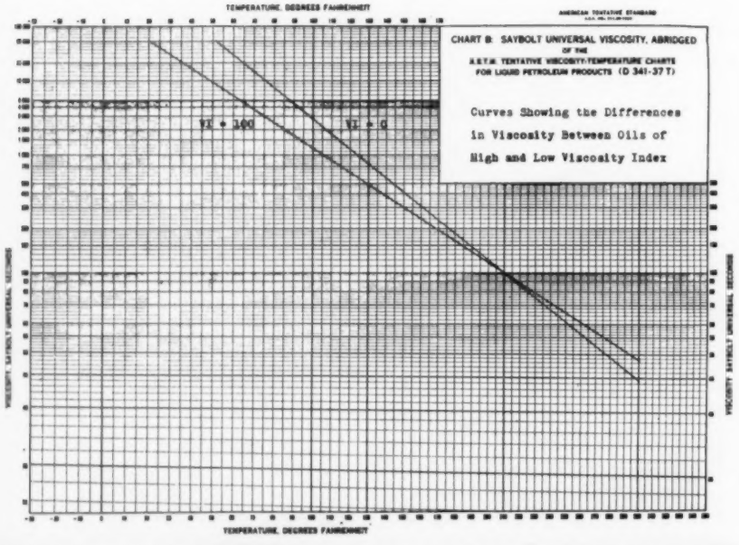


Figure 3—Illustrating the condition of overloaded gears lubricated with a straight mineral oil lacking sufficient load carrying capacity to take care of the pressures developed.

temperatures, etc., excessive wear and in some cases gear failures occurred with straight mineral oils. The development of extreme pressure lubricants solved many problems in this respect, increasing the life of the gear sets and bearings and, in many cases, decreasing maintenance and repair costs. This new type of lubricant is ideally suited to the more compact, higher speed and higher tooth pressure enclosed gear sets, which are now so largely used throughout the steel industry as speed reducers on mill drives, etc.

Figure 4—Difference in actual viscosity between oils of high and low viscosity index.


TEMPERATURE, DEGREES FAHRENHEIT
CHART B SAYBOLT UNIVERSAL VISCOSITY, ABRIDGED
Curves Showing the Differences
in Viscosity Between Oils of
High and Low Viscosity Index
VI = 100
VI = 0
TEMPERATURE, DEGREES FAHRENHEIT

Before the load conditions were fully realized, the first natural step was to increase the viscosity of the straight mineral oils being used. This was done on the theory that the higher the viscosity of the oil the greater load it would carry. While this is theoretically true, it was soon found that the loads involved were such that even the most viscous straight mineral oils could not carry them. Further, with such viscous oils, bearing failures were frequent, particularly on cold starting.

It soon became apparent that oils of a much higher load carrying capacity than could be obtained with any straight mineral oil would have to be developed to take care of the increased loads.

LOAD CARRYING CAPACITY

Since the first requisite of an improved gear lubricant was increased load carrying capacity, naturally some means of measuring this property in the laboratory had to be selected. In most cases, the Timken machine was chosen, although there are other machines which can also be used to test the film strength or load carrying capacity of extreme pressure lubricants. The other machines used for measuring load carrying capacity include the S.A.E. and Almen. These machines are chiefly used for testing automotive extreme pressure lubricants, such as hypoid differential lubricants. Results obtained with the Timken machine are relative and it is impossible to take the results of this test and translate them into the pounds per square inch a particular lubricant will stand in actual service.

Since, as previously mentioned, ordinary straight mineral oil does not have sufficient load-carrying capacity to meet the requirements of the modern gear sets, as well as older sets in which the speeds and pressures have been increased, it is natural to raise a question as to how the load-carrying capacity of any lubricant can be improved.

Practically all extreme pressure lubricants contain addition agents, such as small quantities of complex sulphur, chlorine or phosphorous compounds. The addition of certain soaps, namely lead soap, also aids in increasing the load-carrying capacity. While the manner in which these compounds increase the load-carrying capacity of lubricants is not thoroughly understood, it is generally believed that these materials, under normal conditions of operation, are chemically inactive. Under sufficiently high temperatures and pressures, however, these additives decompose, liberating small amounts of sulphur, chlorine or phosphorous compounds, which combine with the metal to form iron sulphide, chloride, etc. In other words, a minute film of sulphide or chloride on the gear teeth acts as an anti-welding agent. While under extremely heavy loads this minute sulphide or chloride film may be removed, the fresh metal thus exposed reacts immediately with the additional sulphur or chlorine compounds which are liberated. This anti-welding layer which forms is so thin that even with repeated formation of such films there is no measurable wear. The presence of these extreme pressure additives in the lubricant is, therefore, a safety valve, always ready to function when and if needed.

The foregoing applies only when we are speaking of steel on steel, and not when worm gears—bronze on steel—are involved. In worm gear sets we desire additional oiliness, rather than extreme pressure characteristics in the lubricant. For this reason lubricants containing soaps or fatty oils are of value in worm gear lubrication.

Timken readings for both high and low viscosity index straight mineral oils are shown in Table I, since there is an erroneous belief on the part of some that the higher the viscosity index the better the load-carrying capacity of the oil. I presume it is known to all that viscosity index is merely the ratio between the Saybolt universal viscosity of an oil at 100 and 210 F. The viscosity index of any particular oil is due largely to the crude from which it has been derived and the method by which it was refined.

STABILITY

Having obtained a gear lubricant of the desired load-carrying capacity, the next question is whether or not it will resist oxidation in actual service. Should it oxidize and thicken excessively this might prevent free circulation to the bearings and satisfactory lubrication of the gears, particularly at low temperatures. In addition, the formation of troublesome sludge deposits due to excessive oxidation might clog certain of the oil feed lines.

In order to determine this, a laboratory thickening test was devised, which consists of blowing air through the lubricant at a controlled rate at temperature of 300 F. The viscosity of the oil at 210 F is taken after this test and compared to its original viscosity.

This is an extremely severe oxidation test and it was found that the first lubricant developed, while it had good load-carrying capacity, was lacking in stability, as indicated by excessive viscosity increase after being subjected to this laboratory oxidation test. It was then necessary to develop a second lubricant which had the same good load carrying capacity as the first, but did not have the undesirable property of thickening excessively under the conditions of this oxidation test.

This is a striking example of the fact that while it is possible to obtain some one of the predetermined desirable characteristics in a lubricant for a specific job, it does not necessarily follow that the lubricant will be satisfactory, since it may have other undesirable properties.

In order to check the results obtained in the laboratory, experimental oils No. 1 and No. 2 were placed in actual service in a steel mill drive. Table II shows viscosity readings after six months use in this steel mill drive. It will be noted from the viscosity readings after six months service in the same drive that oil No. 2 confirms the laboratory test, in that it is extremely resistant to oxidation or thickening.

RESISTANCE TO WATER WASHING AND EMULSIFICATION

The question then arose as to whether or not oil No. 2, which had satisfactory load-carrying capacity

TABLE I

Tinken Extreme Pressure Test

	Lever load, lb
Straight mineral oil (20 V.I.)	OK at 10
Straight mineral oil (95 V.I.)	OK at 10
Lead soap extreme pressure type lubricant	OK at 35

Viscosity of each lubricant = 120 sec at 210 F.

TABLE II

Actual Service Test in Steel Mill Drive

Oil No. 1

	Tests on new oil	*Tests on oil No. 1 after 6 months use*	*Increase in viscosity, %*
Viscosity at 100 F...	2500	4205	68
Viscosity at 210 F...	135	163	21

Oil No. 2

	Tests on new oil	*Tests on oil No. 2 after 6 months use in same drive as above*	*Increase in viscosity, %*
Viscosity at 100 F...	2724	2822	3
Viscosity at 210 F...	135	137	2

and good stability from an oxidation standpoint, but was still under laboratory development, would be satisfactory in other respects. In this connection it was necessary to determine if the lubricant would resist removal by water from metallic surfaces, and also if the presence of excessive quantities of water would cause the formation of troublesome emulsions. Accordingly, a miniature gear set test was developed to prove these points.

Tests indicated that the lubricant in question was very good in resisting water washing, and was not removed even when the gears coated with the lubricant were deluged with water. This miniature gear set was also operated with several inches of water in the bottom of the case, the lubricant floating on the water. Even under these extreme conditions of agitation of the oil-water layer no emulsification resulted, the oil and water separating immediately on shutdown of the unit.

After completion of all the foregoing laboratory work, before the lubricants in question were actually placed on the market, they were subjected to actual service tests in three or four plants. In order to show the changes which a lubricant, such as oil No. 2, undergoes after 8 months service in a steel mill drive, see Table III. It will be noted that after 8 months use the lubricant showed practically no change in viscosity, had lost none of its load-carrying capacity, and was still in excellent condition. All this should give an idea as to the detailed investigation which must be made before a lubricant, developed for a particular type service, is marketed.

The question now arises as to when it is advisable to adopt the use of such extreme pressure type gear lubricants. The factors to be considered are loads and operating conditions, whether or not satisfactory results can be secured with the straight mineral type gear lubricants, and also if a sufficient margin of safety exists to permit use of the latter. Naturally, this is a difficult problem for the operator to decide, and warrants consultation with both the gear manufacturer and the lubricant supplier. With the added factor of safety which comes from the use of extreme pressure lubricants of the type previously discussed, their adoption is completely justified.

EXTREME PRESSURE GREASES

Just as there was a demand for extreme pressure gear lubricants, so there has developed, over the past several years, a demand for greases having extreme pressure characteristics. Such greases were found to be advantageous in large roller bearings, subjected to severe loads. Contrary to popular opinion, both sliding and rolling action occurs in ball and roller bearings. Where sliding pressures are excessive the use of an extreme pressure type of lubricant is frequently necessary to prevent welding or scuffing.

As in the case of gear lubrication when roller or ball bearing failures resulted from the grease in use being unable to provide an adequate film to prevent metal to metal contact, the first step taken to overcome this difficulty was the preparation of greases containing mineral oils of higher viscosity than had been previously used in conventional cup greases. In ordinary cup greases the mineral oil constituent usually has a Saybolt universal viscosity at 100 F ranging between 100 and 500 seconds, whereas the higher viscosity mineral oil greases made up used mineral oils having Saybolt universal viscosities at 210 F ranging from 75 to 125 seconds. In many cases these greases containing a higher viscosity mineral oil solved the problem, although frequently the load carrying capacity of the grease was not sufficient to take care of the conditions involved.

So, extreme pressure type greases came into existence. Again, the load-carrying capacity was obtained by adding to the mineral oil constituent materials such as those previously described under extreme pressure gear lubricants. The Timken machine was also employed to determine, in the laboratory, the load-carrying capacity of the various greases.

Another requirement of extreme pressure greases, particularly for steel mill service, is that in addition to the grease acting as a lubricant it must also assist in preventing the entrance of contaminants, such as mill scale, water, etc. Since lime soap greases are water insoluble, most steel mill extreme pressure greases are made up using lime soap. Other factors which must be considered in the development of extreme pressure

TABLE III

Chart Showing Stability of Oil No. 2 In Actual Service

	Oil No. 2, new	*Oil No. 2 after 8 months service in steel mill drive*
Viscosity		
at 100 F	2724	2822
at 210 F	135	137
Corrosion, Copper Strip at 212 F	No	No
Corrosion, Steel Strip at 212 F	No	No
Sediment, per cent	Trace	0.15
Mineral acid	None	None
Timken E.P. test	OK at 35	OK at 35

TABLE IV

Timken Extreme Pressure Test Cup Grease versus E. P. Grease

	Lever load, lb.
Ordinary cup grease No. 2	OK at 10
Extreme pressure grease No. 2	OK at 40

greases include pumpability, since one of the chief means of supplying extreme pressure grease to steel mill bearings is through central pressure systems, and extreme stability, so that no oil or soap separation will occur at the temperatures involved in the particular operation. Should the grease be unstable and soap separation occur, difficulty will be experienced with clogging of the grease lines.

All these factors must be carefully considered in the development of extreme pressure greases, and the points previously mentioned carefully checked in the laboratory, before the experimental greases are released for practical service tests, prior to marketing.

Many will contend that they have no requirements in their mills for extreme pressure greases, since they are obtaining entirely satisfactory results with ordinary cup greases, or greases made up using high viscosity mineral oils, as previously mentioned. If satisfactory results are obtained with these greases, and there is no danger of sudden loads requiring the extreme pressure type grease, there is, of course, no reason for the use of the latter, although, as in the case of extreme pressure gear lubricants, the factor of safety when using the extreme pressure type greases should be considered. These latter greases have also been found satisfactory for general purpose use.

IMPROVED OILS FOR CIRCULATING SYSTEMS

Everyone is familiar with the recent development and extension of sleeve type bearings in steel mill service. These bearings are of precision manufacture, and only the highest quality straight mineral oil should be used, in order to protect the investment involved. It has been found that the load-carrying capacity of straight mineral oils is ample for the lubrication of bearings of this type, since in these bearings the load is distributed over a large area, rather than concentrated at a few points, as may be the case in gear sets. For this reason, oils of high load-carrying capacity are not necessary. Oil under constant pressure is used to flood these bearings. The manufacturers calculate the viscosity of the oil required according to the size of the bearings and type of service. They prefer oils of fairly high viscosity index in order to keep the viscosity of the oil as constant as possible with temperature changes.

The manufacturers specifications further include a demulsibility requirement of 1620 minimum, which means that when 27 cu cm of oil and 53 cu cm of distilled water are stirred together by rotating with a paddle for 5 minutes at 1500 rpm, the 27 cu cm of oil must separate from the mixture completely within one minute after stopping the stirring. Demulsibility means the maximum rate of separation in cu cm per hour.

It is important to remember that this 1620 demulsibility requirement refers only to new oils, since as soon as oil becomes contaminated in use with a slight quantity of dirt, mill scale, etc., the demulsibility test is lowered appreciably. New oils which show poor demulsibility tests usually contain minute quantities of sulphonates, soaps, etc., which result from treatment of the oil in the refinery. These extraneous materials are completely removed from the more highly refined oils, either by additional treatment or by filtration, so that excellent separation from water is obtained.

The reason why the manufacturers of such bearings insist that the new oil show excellent separation from emulsion is due to the fact that, despite most careful sealing, at times appreciable quantities of water will get into the oil. It is important that the oil release the water quickly, so that troublesome emulsions are not formed.

Another essential characteristic of oil for use in circulating systems is that it must be extremely stable toward oxidation. This means that it should not change appreciably in service, forming insoluble materials which may settle out, clogging the oil lines and resulting in oil starvation of the bearings, etc.

In order to obtain oils which are extremely resistant to oxidation it is necessary to start in the refinery, by the proper selection of crudes, and then refine the oils derived from these crudes in such a manner that the most stable oil possible will be obtained. There are many laboratory tests to measure the resistance to oxidation of oils. One of the most commonly used consists of taking 300 cu cm of oil, placing it in an oil bath maintained at 341 F, and blowing air at the rate of 10 liters per hour into the oil. Samples are taken every 24 hours for sludge determination, and every 48 hours for viscosity determination. Sludge content is measured by determining by weight the material insoluble in the oil when it is diluted 10 times with a light naphtha.

We never accept any laboratory oxidation test as the final criterion as to the stability of a particular oil, since we have found that in many cases laboratory results do not correlate with those obtained in actual service.

It is fitting here to discuss oxidation of oils, in that any oil will oxidize or break down if conditions of heat, aeration, etc., are sufficiently severe. Oxidation of an oil is greatly accelerated by the presence of metallic materials, particularly brass, copper and iron, as well as by the presence of moisture. The quantity of air which is mixed in with the oil also has an appreciable effect on the rate at which the oil will break down. Naturally, high temperatures accelerate oil oxidation. It has been found that at elevated temperatures increasing the temperature of the oil even 15 or 20 F will double the rate of oxidation. Usually the path which oxidation of an oil begins with is the formation of complex, oil-soluble organic materials which are readily detected by increase in neutralization number. The presence of these organic materials in themselves causes no trouble. As oxidation progresses, however, they are converted into insoluble sludge, which settles out of the oil. These sludge deposits vary in appearance, some drying to yellow varnish-like deposits, while others remain gummy.

It is usually noted that the first place where sludge deposits form in a circulating system is either on the oil cooler or in the coolest part of the system, and in that part of the system where there is the least oil circulation and the sludge has a chance to settle out. This is one reason why, after sludge has started to form in the oil, it is desirable to centrifuge the oil at as low a temperature as possible.

DISCUSSION

PRESENTED BY

N. C. BYE, *Chief Engineer*, Henry Disston & Sons, Inc., Philadelphia, Pennsylvania

H. B. CLEAVELAND, *Lubrication Engineer*, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. F. COFFIN, *Superintendent*, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

C. R. HAND, *Lubricating Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland

F. E. ROSENSTIEHL, *Supervisor*, Technical Service, The Texas Company, New York, New York

N. C. BYE: Having only a very small number of enclosed gear sets, we are not in a good position to talk much about them. We do, however, have a number of circulating systems using oil. I would like to know whether there would be any difference in the action of a standard type oil filter between the straight mineral oil type of lubrication and the extreme pressure type of lubrication, which is a compounded type, after they have been in service a certain length of time. Do these extreme pressure types of lubricants form compositions which will affect the filtering or the cleaning device, or should you have different types of cleaning devices?

Many hydraulic systems which use oil and which do not have extreme pressure types of lubricants run at fairly high temperatures and a good many of them have oil coolers. There is a great tendency for sludges to form in those lubricants and these sludges have a carbonaceous characteristic, that is, a gritty substance which has great wearing property on the pumps. Should those lubricants be of a nature which will not form the carbonaceous material, or is there something which will remove it so that the pump wear can be eliminated to a greater extent than at the present time?

H. B. CLEAVELAND: In lubricating a gear set with a pressure system, isn't it preferable to put the oil spray on the top of the teeth? My experience has been to put the oil spray on top of the teeth, then let it come around with rotation. I noticed in Figure 2 the oil dropping down on a pan.

L. F. COFFIN: It is encouraging to users of oil in the steel industry to know that the problems of oil are being attacked in such a scientific manner. We have seen in this paper some basic information to apply in a practical manner. It is of course true that it may be necessary in some cases, to use extreme pressure lubricant in gear sets, large or small, on account of the increased loads or on account of the original limitations of design. Very frequently, however, the use of such a lubricant could be avoided by making sure that the entire load carrying surface of the tooth was actually carrying the load. Too frequently we find cases of gears having a width of face of say 12 in. where only 3 or 4 in. are actually in contact. In such cases, the answer of course, is not to use extreme pressure lubricants but to lap in the teeth so that the entire 12 in. is effective. It has been our practice in important cases, either to have machinery lapped in at the manufacturer's plant or do this lapping at our own plant during erection. In circulating systems, we are still opposed to the use of extreme pressure lubricants where we can possibly avoid it, on account of their more rapid oxidation and more danger of emulsification.

C. R. HAND: Mr. Rosenstiehl's paper has shown very clearly the value of laboratory analysis to operators as well as refiners. That is, as a yard stick to measure quality of products before they are put into service, and as a means of following their condition during service. However, the laboratory tests are only the guide when other important factors are as they should be. If speeds and loads are increased on some piece of equipment, attention must be given to the lubricants.

If the original design required exteme pressure products, then increased loads or speed will mean trouble. On the other hand, equipment which has operated satisfactorily on straight mineral products may be overspeeded and overloaded and extreme pressure products may keep the equipment running. This applies particularly to gears and ball and roller bearings.

Statement is made that lubrication engineers are called in when new equipment is being designed. This unfortunately is not always the case. Too often the lubricating engineer gets into the problem after the equipment has been received. Purchasers should insist that a competent lubricating engineer be consulted on all equipment furnished. Equipment which is designed so as to require extreme pressure compounds when newly installed should be avoided, unless the expected duties and life of such equipment is short.

Much work has been done and is being done on the problem of oxidation and acid formations in circulation oil systems. Turbine systems have come in for much consideration in this problem. In some turbines oil useful life is as low as three weeks with acids reaching 5.0-7.0 mg KOH. In cold circulation systems, 10 and 12 years have been obtained with acids less than 1.0. In turbine systems, the oil temperatures range from 150 F up, and acids attack all bronze and copper parts rapidly. In some cases the oil turns green. This requires immediate shut down and clean out. Various additives are being tried with no marked success in retarding this oxidation. Greases have been very materially improved as the result of cooperation between operating engineers and the various oil company research departments. Soap contents have been lowered by the use of heavier oils. Cold tests have been lowered. Greases that are well made do not bleed or allow soap and oil to separate. Installation of fine filters at the soap kettles has given us grease almost free of unburned lime and soda particles which were always present in the old style grease. Extreme pressure compounds have been of utmost value when the manufacturers cooperated with the operators in their development and application. Cooperation of all concerned in the future will do much to get long life lubricants and equipment.

F. E. ROSENSTIEHL: The first question I will try to answer is that raised by Mr. Hand, namely, recondi-

tioning of extreme pressure type gear oils as compared to straight mineral oils.

To the best of my knowledge, either type lubricant today can be satisfactorily reconditioned, using conventional methods. Some of the older type extreme pressure gear oils contained lead oleate, which was not completely soluble in oil and frequently difficulty was experienced due to the separation of this lead soap, either in service or while passing through the reconditioning unit. Today most high grade extreme pressure gear oils containing lead soap employ lead naphthenate, which is completely soluble in the oil. As far as I know no difficulty whatsoever has been experienced in reconditioning this type lubricant. In our development of lubricants of this type we have repeatedly passed lubricants containing lead naphthenate through a centrifuge, and also put a stream of water into the centrifuge with the lubricant, and found that it was impossible to cause any of the lead soap to separate out. We have further proof of this in that examination of this gear lubricant after several years service in steel mill drives shows no loss of lead naphthenate content.

Summing up, our experience has been that the contaminants which get into the extreme pressure type gear oil can be removed as readily as from a straight mineral oil.

As to the question of sludge formation and carbon deposits in hydraulic systems, it has been observed that very often hot spots, that is, localized abnormally high temperatures, may prevail. Sometimes these temperatures will be high enough to break down portions of the oil, forming carbonaceous material and sludge. It is not easy to explain or locate these hot spots and normally it is felt that they are due to some abnormal mechanical or operating condition. I doubt if the use of an extreme pressure type oil would be of any value whatsoever in correcting such a condition, assuming, of course, that the high temperatures developed are not due to the lubricant in use being unable to prevent metal to metal contact. The selection of a high grade, extremely resistant to oxidation straight mineral oil would be my first choice of an oil for use in a hydraulic system. Sooner or later, however, even the most highly refined oil will break down if subjected to extremely high temperatures.

I am unable to explain the gritty substance causing pump wear, unless the carbon formed is of such a hard nature that it acts as a mild abrasive. No solvent will dissolve this carbonaceous material. Possibly an oil of low carbon residue content would be of value in preventing the formation of these objectionable carbon deposits, although, as I see it, elimination of the high temperatures involved is the best solution.

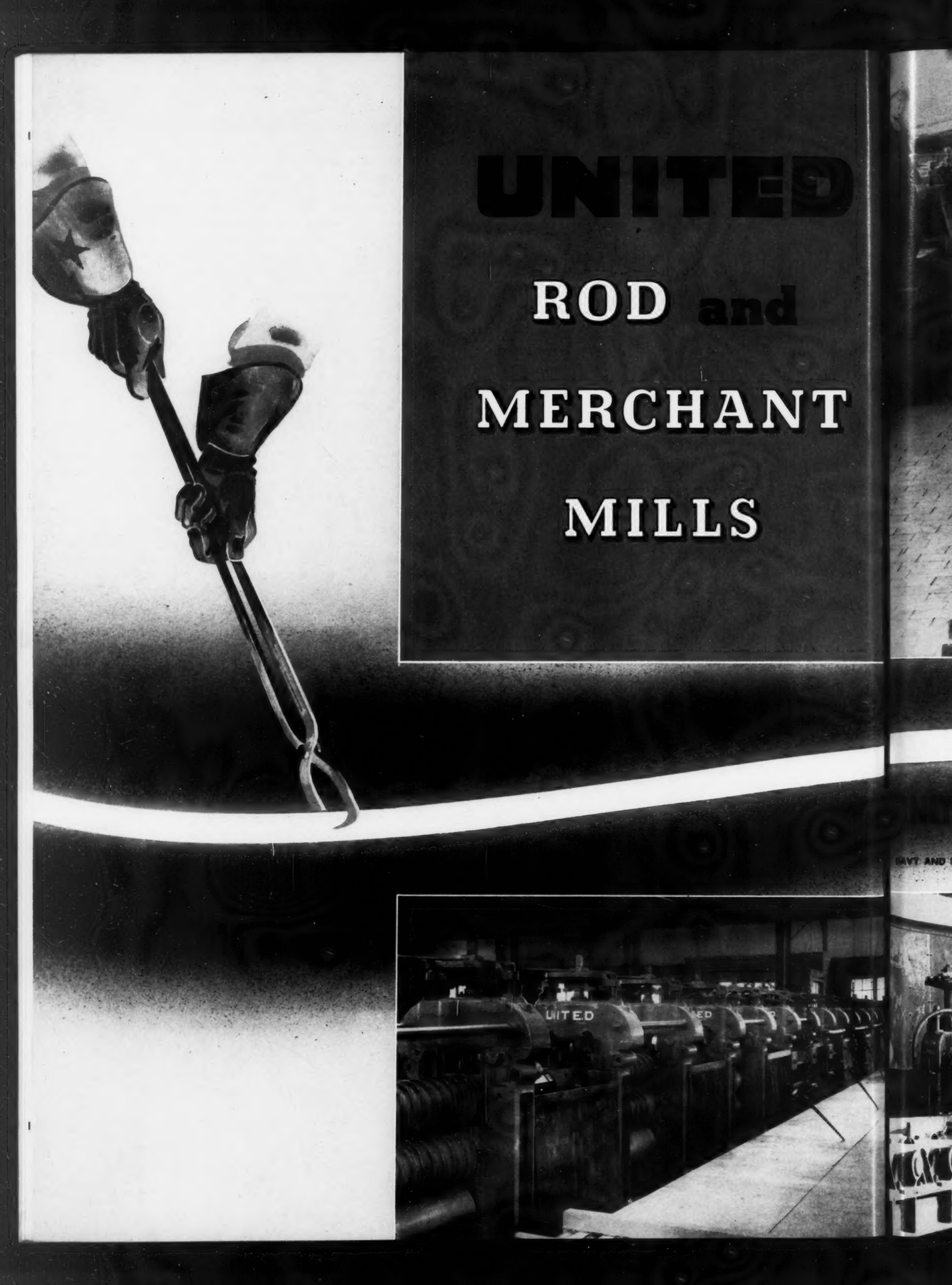
In regard to Mr. Cleaveland's question as to the best point at which the oil spray should be applied to the gear teeth, I believe the gear set manufacturers have thoroughly studied this problem, and worked it out to the best of their ability in the design of the lubrication systems of their particular gear sets.

Mr. Coffin's remarks are so obviously correct that any comment I might make would be superfluous. If all operators of gear sets would follow Bethlehem Steel Company's practices, as outlined by Mr. Coffin, we in the oil industry would be relieved of a lot of headaches. By proper lapping in of gears the lubricant is relieved of a considerable amount of load which it would otherwise have to carry.

Mr. Hand's remarks as to steam turbine lubrication are particularly interesting. Our experience has been that the neutralization number of a used turbine oil may go as high as 7 without the organic acids present giving any corrosion difficulties. On the other hand, the neutralization number must be considered, along with other characteristics of the oil, in deciding whether or not it should be removed from the system. Our practice is to watch the neutralization number increase on all turbine installations. We are not so much concerned with the gradual increase in neutralization number as we are with the sudden rise.

Mr. Hand's mention of acid attack is worthy of note, since, in my experience I have seen only one turbine operation where the oil developed corrosive acids. It is extremely rare indeed when a straight mineral oil develops corrosive acids, although it must be admitted that under extreme conditions of operation such acids may form.

Mr. Hand's suggestion that lubrication engineers get into the problem of lubrication of equipment before it is received is an extremely good one, and I believe the system he has worked out of going over with the equipment manufacturer all details in regard to lubrication before the equipment in question is delivered is one which could be profitably followed by all concerned.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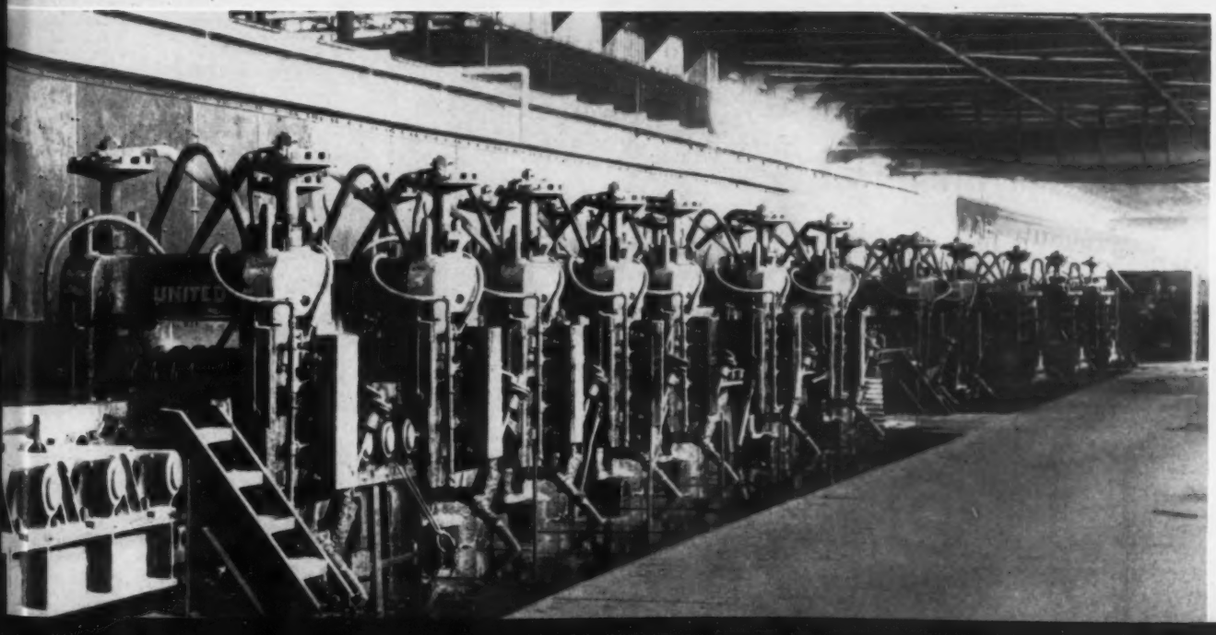

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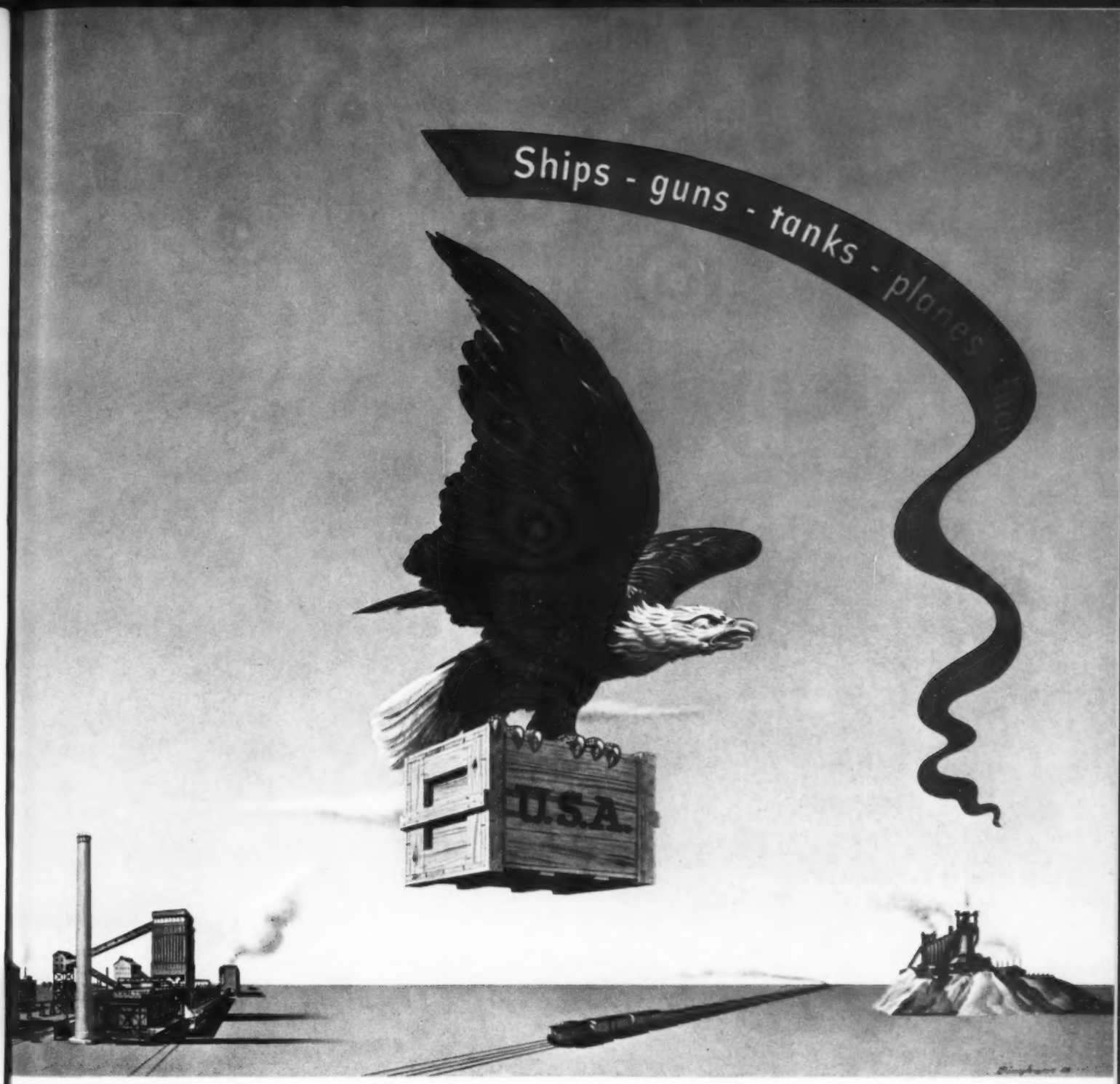

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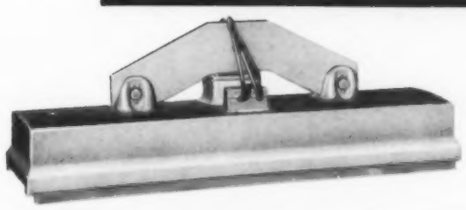

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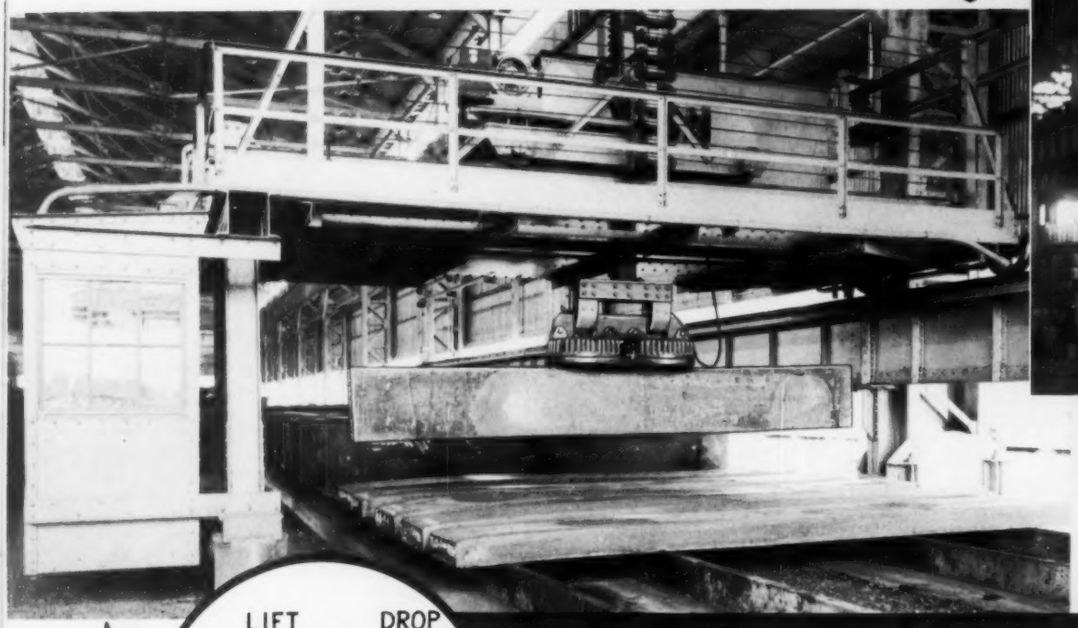
EC&M Duplex 29-R Magnet with special hanger for stirrup-hook attachment on slab-turning crane. Center-line of magnets is placed on edge of slab and when lifted, the slab rotates on magnets and hangs vertically as shown. Magnets and slab are then lowered until edge of slab touches ground-skids. Operator then starts bridge motion of crane while continuing to lower which completes the turning operation.



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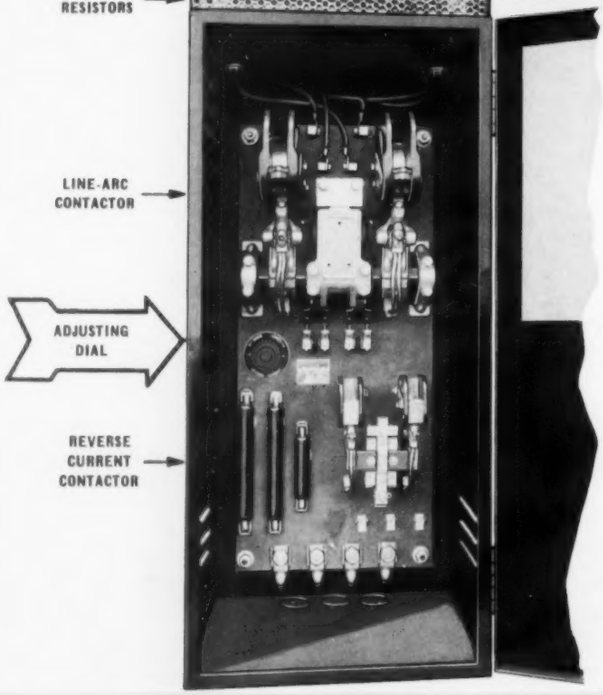

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LUBRICATION GUIDE FOR BALL BEARINGS

▲ Fully appreciating the many problems that are faced by ball bearing users in obtaining suitable greases for re-lubricating ball bearings, the Annular Bearing Engineers' Committee has been, over a period of several years, undertaking a research program from a chemical and mechanical standpoint to obtain a solution. For years there were many greases available, but these were chiefly of lime soap bases which had limitations. Due to the troubles experienced by the ball bearing industry, a cooperative effort was made, and, as a result, much better greases are now available.

The standards which follow have been developed from practical experience and careful analysis by the Annular Bearing Engineers' Committee, but it may become desirable to revise these occasionally to keep abreast of the continual development in the lubricant field. The user will appreciate that some lubricants which conform to these standards may not be suitable for all applications. It should also be appreciated that some greases which do not conform may sometimes be satisfactory. For all applications, the user of the bearing is advised to obtain the approval of the grease manufacturers.

The A.B.E.C. has developed a grease testing machine for determining the physical characteristics of greases and a number of the properties called for in these standards are determined with this machine.

ABEC Grease Standard

ABEC I.—Type of grease recommended for speeds and temperatures as indicated in Guide for Relubrication of Ball Bearings.

Greases shall be free from dirt, abrasive matter, fillers, excessive amounts of moisture and free acid or free alkali.

Nature of soap—Soda or soda lime; maximum lime soap 5 per cent of total weight of grease; uncombined lime 0.10 per cent maximum.

Worked penetration, A.S.T.M.—190 minimum.

Running torque, A.B.E.C. test—60-300 g cm.

Leakage: Through plate seal—5 per cent maximum; Left in bearing—75 per cent minimum.

ABEC II.—General purpose greases, suitable for grease gun applications, for modern speeds and temperatures as indicated in Guide for Relubrication of Ball Bearings.

Greases shall be free from dirt, abrasive matter, fillers, excessive amounts of moisture and free acid or free alkali.

Nature of soap—Soda or soda lime; maximum lime soap 5 per cent of total weight of grease; uncombined lime 0.10 per cent maximum.

Worked penetration, A.S.T.M.—260 minimum.

Running torque, A.B.E.C. test—60-450 g cm.

Leakage: Through plate seal—20 per cent maximum; Left in bearing—75 per cent minimum.

Oxidation: Greases shall show no evidence of deterioration following 18 months storage in bearings in individual sealed boxes or packages as indicated by oil leakage, hardening,

GREASES FOR RELUBRICATION OF BALL BEARINGS

(For excessive moisture conditions, a water repellant grease may be required.)

Operating temperature Range, F.	Speed Factor (Bearing bore in mm x rpm of shaft)			
	Up to 75,000	75,000 to 150,000	150,000 to 300,000	300,000 to 450,000
	Grease	Grease	Grease	Grease
—50 to +125	No recommendation	No recommendation	No recommendation	No recommendation
—10 to +125	ABEC-II*	ABEC-I	ABEC-I	No recommendation
32 to 150	ABEC-II	ABEC-I	ABEC-I	No recommendation
60 to 200	ABEC-II	ABEC-I	No recommendation	No recommendation
Over 200	No recommendation	No recommendation	No recommendation	No recommendation

*ABEC-I may be preferred for some applications.

or gum formation of the grease, or by loss of free turning by hand.

Alternatively, the grease shall show no change in consistency, drop point, or neutralization within the limits defined below,* nor more than 5 lb drop in oxygen pressure following a 100-hour run in Norma-Hoffmann oxidation bomb at 210 F and 110 lb initial oxygen pressure, using a 20-gram sample on standard glass sample dishes. When tested under the same conditions with the addition of a piece of sheet copper partially immersed in the sample, there shall be no evidence of stain or corrosion of the copper strip, nor any evidence of physical change in the grease after six hours of exposure.

ABEC Grease Testing Machine Test Procedure

(1) Calcium soap greases shall be tested with an oil bath temperature maintained at 80-85 F, and at 150 F.

(2) Sodium soap greases shall be tested with an oil bath temperature maintained at 80-85 F, at 150 F, and at 220 F.

(3) The test bearing shall be a Conrad type, single shielded, S.A.E. 204, assembled into the test fixture with the shield at the bottom. These bearings can be purchased from any of the ball bearing manufacturers and should be specified for the ABEC grease testing machine.

(4) The bearing seal on the motor shaft extension should be checked periodically with a dial indicator and adjusted if necessary, to run true within .003 in. total indicator reading on the bearing seat and the shoulder in radial and axial directions, respecively.

(5) The bearings, which shall be furnished coated with a rust preventive, should be prepared for test by washing same in mineral spirits which conforms with ASTM specification D-235-39, after which they should be dried out so that there is no condensate present. The bearing is to be packed with a quantity of grease equivalent to 60 per cent of the air-space volume of the test bearing, this grease to be put into bearing so that it is level full with the top of the bearing. The bearing is then to be rotated by hand to distribute the grease over the contacting surfaces of the bearing.

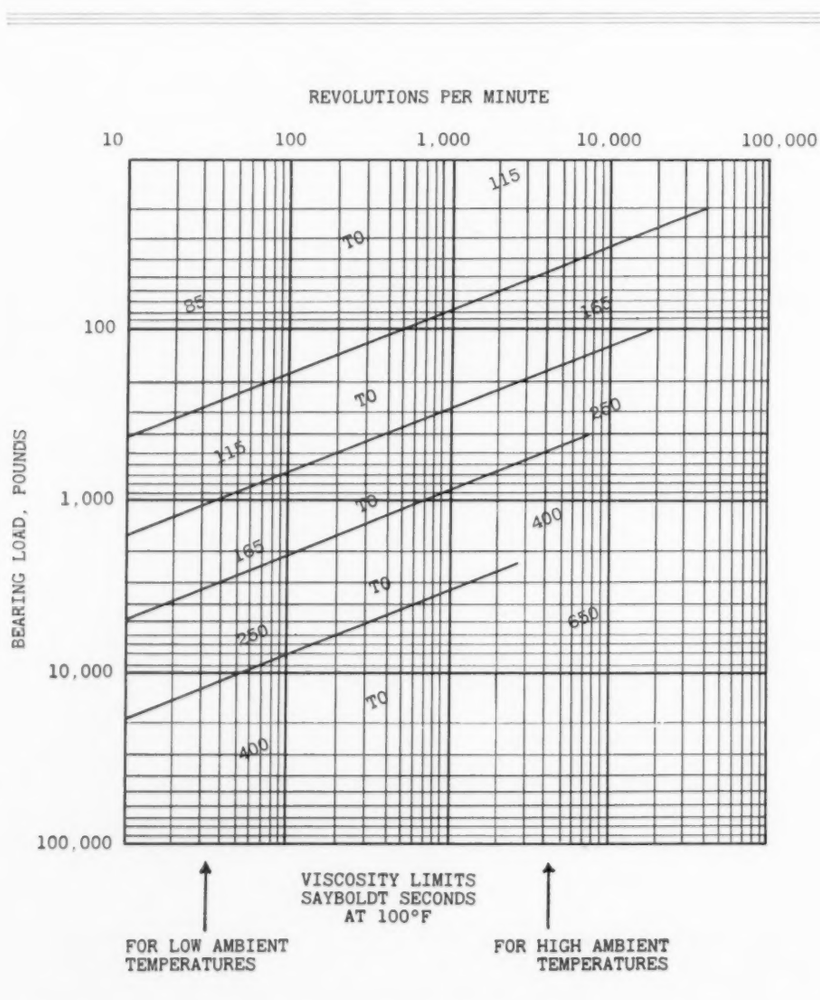
(6) The test at each temperature shall be for 20 minutes duration.

(7) Tests shall be conducted with one sample and shall be checked between tests to determine amount of leakage; after determining percentage of leakage, the grease which has been thrown out or leaked through shall be returned to the bearing for subsequent tests. All grease which leaks through the bearing shall be collected and weighed, and the amount of grease left in the bearing shall be determined by the difference in weight.

(8) Between successive runs, the temperature shall be raised at the rate of 10 to 12 F, per minute with bearing at rest.

(9) The torque shall be recorded at the end of 0-1-2-3-4-5-6-7-8-9-10-15 and 20 minutes.

(10) Observations of separation, change in structure, change in consistency, leakage, and aeration shall be made during the tests.



Lubrication of Anti-Friction Bearings With Oil

The friction torque in a ball bearing lubricated with oil consists essentially of two components. One of these is a function of the bearing design and the load imposed on the bearing and the other is a function of the viscosity and quantity of the oil and the speed of the bearing.

It has been found that the friction torque in a bearing is lowest with a very small quantity of oil, just suffi-

* Consistency ASTM penetration or equivalent and drop point Shell Ubbelohde shall not increase more than 10 per cent.
Neutralization numbers made on grease samples before and after 100-hour accelerated oxidation, or 18 months' storage test, must not show a total change of more than the equivalent of 10 mg. of KOH per gram of grease, nor shall the neutralization number following 100 hours oxidation show acidity exceeding the quivalent of 5 mg. of KOH per gram of grease.

cient for form a thin film over the contacting surfaces, and that the friction will increase with greater quantity and with higher viscosity of the oil. With more oil than just enough to make a film, the friction torque will also increase with the speed.

The energy loss in a bearing is proportional to the product of torque and speed, and this energy loss will be dissipated as heat and cause a rise in the temperature of the bearing and its housing. This temperature rise will be checked by radiation, convection and conduction of the heat generated to an extent depending upon the construction of the housing and the influence of the surrounding atmosphere. The rise in temperature, due to operation of the bearing, will result in a decrease in viscosity of the oil and, therefore, a decrease in friction torque compared with the friction of starting, but soon a balanced condition will be reached.

With so many factors influencing the friction torque, energy loss and temperature rise in a bearing lubricated with oil, it is evidently not polsible to give definite recommendations for selection of oil for all bearing applications, but two general considerations are dominant:

1. The desire to reduce friction to a minimum, which requires a small quantity of oil of low viscosity.

2. The desire to maintain lubrication safely without much regard for friction losses, which results in using larger quantities of oil and usually of somewhat greater viscosity in order to reduce losses from evaporation or leakage.

This second condition is most frequently met and in view of the broad outline of lubrication with oil made above, the attached chart has been made up for selection of viscosities of oil for various operating conditions.

The operating speeds (rpm) are given on one coordinate of the diagram and the bearing loads in lb on the other, both to a logarithmic scale. The lines intersecting the coordinates indicate viscosity groups for oils that are preferred for these loads and speeds. When ambient temperatures are low the lower viscosity ranges should be used and with high operating temperatures the higher viscosities should be selected.

When bearings have to operate in a wide range of temperatures, an oil that has the least changes with change in temperature, i.e., an oil with high viscosity index, should be selected.

In the great majority of applications pure mineral oils are most satisfactory, but they should, of course, be free from contamination that may cause wear in the bearing, and they should show high resistance to oxidation, gumming and to deterioration by evaporation of light distillates, and they must not cause corrosion of any parts of the bearing during standing or operation.

It is self-evident that for very low starting temperatures an oil must be selected that has sufficiently low pour-point, so that the bearing will not be locked by oil frozen solid. In special applications, various compounded oils may be preferred, and in such cases the recommendation of the lubricant manufacturer should be obtained.

NEW MOTORS ADDED TO TRI-CLAD LINE

▲ Three new motors—a vertical general-purpose polyphase motor, a vertical shielded polyphase motor (1 to 20 hp) and a vertical shielded single-phase motor (1 to 5 hp)—have been added to the General Electric Tri-Clad family. The shielded-type motors are especially suited to pumping applications, and the general-purpose motor is suitable for use in the machine tool industry as well as for agitators, mixers, and similar applications.

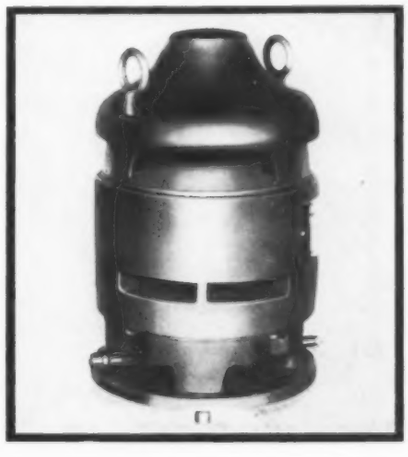
General Purpose Type

The compact, cast-iron frame and cover of the general purpose motors are designed to give added protection to electrical parts, without adding materially to the over-all height. The use of Formex wire, new punchings and coil shapes, double-end ventilation, and balanced design are features contributing to long life.

Accurate alignment of the motor to the driven unit is assured by machined rabbets on the stator frame and base. Rotating weight and thrust are solidly transmitted to the supporting base through the lower bearing, which is fitted to a one-piece base. Bearings are of the deeply grooved type, and are encased in machined cast-iron housings.

All openings in the general-purpose motor are shielded to bar the entrance of chips or other falling objects. Many features of this Tri-Clad motor contribute to convenience of operation. Accessibility of grease fittings allows rapid lubrication without disassembly of the motor; the location of eyebolts makes the motor easy to handle; speed measurements are taken by removing the monogram cap from the upper end shield; a variety of bases makes it possible for this motor

New addition to the G-E Tri-Clad motor line provide units suitable for pumping applications, machine tools, agitators, mixers, etc.



to meet many applications and mounting requirements.

Shielded Types

The polyphase shielded-type motors are available in either solid-shaft of hollow-shaft construction, while the single-phase shielded-type motors are available only in solid-shaft construction. Both shielded types are for normal-thrust or high-thrust applications. The cover is contoured to deflect dripping liquids and falling objects. All openings in the stator frame and end shields are protected against the entrance of splashing liquids. Air is discharged downward at low velocity, thus permitting little or no dust disturbance around the motor.

These motors are suitable for outdoor operation except where extremes of moisture, dust, or other harmful agents make the selection of fan-cooled motors more economical. All frame sizes have common mounting dimensions, making possible interchangeability of many horsepower and speed combinations, including single-phase ratings. The motors can be rotated to any one of four base positions without modification of the supporting structure.

To facilitate installation and impeller adjustment in pump installations, these motors can be obtained with hollow shafts. In such installations, the pump shaft passes through the hollow motor shaft and is supported on the upper end by an adjusting nut. Torque is supplied to the pump shaft by either a nonreversing ratchet or jaw-type coupling.

The nonreversing ratchet eliminates motor reversal which might result from the reversal of phase rotation, or from the backward flow of water through a pump, which would cause turbine action. The jaw-type coupling is a simple means of connecting the motor to the driven machine, where pump reversal is unimportant.

STAMP HOLDER OFFERS NEW FEATURES

▲ A new steel stamp holding device as announced by James H. Mathews and Company, Pittsburgh, Pennsylvania, was developed primarily for safety in hammer struck stamp impressions on steel products. Defense industries required to stamp workmen identification, inspection identification and other vital data, while moving along at top speeds find the device desirable, not only from a safety standpoint, but find they are getting a much more legible stamping job at a greater speed. Better stamping is encouraged with this device, because the workmen need not fear bruised fingers caused by flying stamps, struck by glancing blows.

The stamp holder can be used for stamping round or flat products. The base of the holder is V shaped, which allows a perfect right angle alignment of stamp when stamping round products. The stamp is held in place by means of a "Shepherd Hook" holding device. The stamp floats up or down, in order to find its own location on varying diameters of round or oval shapes.

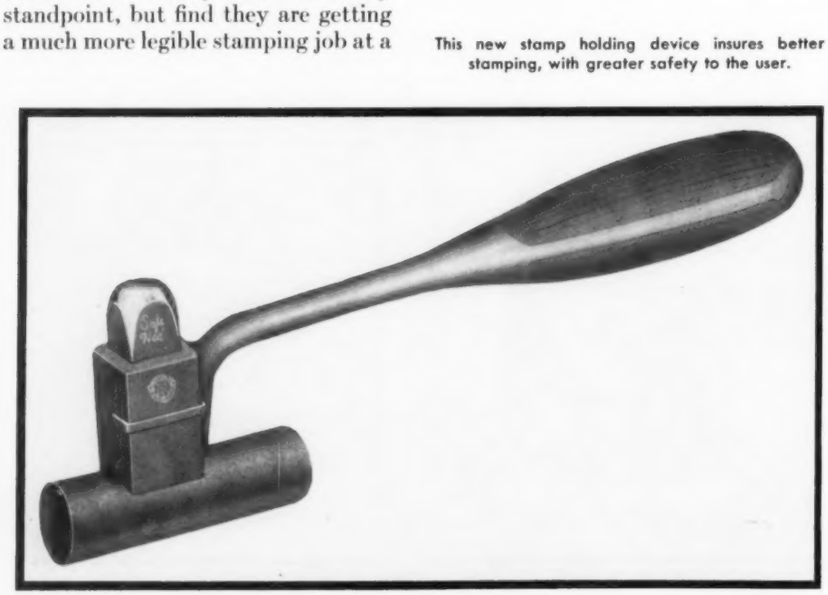
An outstanding advantage of the holder is found in its fool-proof factor, in that it cannot be used upside down. This is highly important in today's marking requirement of heat numbers, lot numbers and contact numbers when an upside down 9 can lead to serious consequences.

The holder can be held at any angle or in any position, with no effect on satisfactory stamping. The stamps cannot drop out when not in use, nor will they bounce out from rebounds caused by forceful hammer blows.

The very nature of its holding method allows the stamp in the holder to be in contact with part to be stamped, when hammer blow is delivered assuring a thoroughly legible impression.

Holder can be made to hold any size steel stamp.

Some users prefer to have stamps fixed and not removable from holder. In this case, the steel "Shepherd Hook" is substituted by a steel pin. The pin is peeved at both ends, assuring a firm seal.



This new stamp holding device insures better stamping, with greater safety to the user.

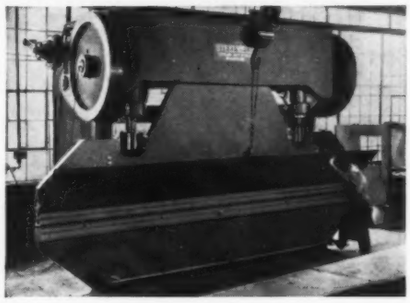
BENDING PRESS OF WELDED CONSTRUCTION

▲ The Steelweld Machinery Division of the Cleveland Crane and Engineering Company, Wickliffe, Ohio, announces a new steelweld bending press, Model L5½-12 with double bed and ram extension for bending and forming plate up to 20 feet in width.

Various plate thicknesses may be handled depending upon the plate width. The picture shows a 20-foot plate 5/16 in. being bent. The same machine will bend ½ in. plate up to 12 ft in width, and even heavier plate that is less in width.

Like all presses in the steelweld line, the frame is of the one-piece all-welded steel construction and will remain rigid for life.

All gearing is protected in metal enclosing covers. Shafting and machinery are located at rear of the machine, thus preventing damage from bent-up plates, crane hooks, etc.



The one-piece all-welded construction of this bending press gives rigidity and long life.

Two solid forged steel eccentrics, one on each end of the machine, operate the ram. Each eccentric has three extra large main bearings and an eccentric bearing. The bearings are automatically lubricated by two pressure-type oiling units mounted on either end of the machine.

The main drive clutch is of the heavy multiple-disc type and is easily adjusted without tools. Usual brake troubles are eliminated by using a clutch, that is a duplicate of the main clutch, for braking.

Bending, forming, blanking, drawing, and multiple-punching operations may be performed on steelweld presses. Gauges and indicators provided make it a simple matter to obtain identical results repeatedly with a set of dies.

STRIP MILLS TO PRODUCE PLATE

▲ Much of the steel plates for the nation's merchant ships henceforth will come from mills that last year were turning out sheet steel for automobile bodies, C. E. Adams, chief of the iron and steel branch, war production board, announced recently.

The plan for the use of plates from converted strip mills was worked out by representatives of the branch and of the maritime commission and will go into effect immediately. It is expected to speed greatly shipments of steel for the "Liberty Ship" fleet and to help solve one of the most perplexing materials problems, that of abnormal demand for plates.

Under the plan, items of similar size were grouped together in a new bill of materials. Specific items will be obtained from strip mills with facilities suitable for the production of the sizes involved. Thus, any one mill will deliver plates of a specific size to a number of shipyards.

High speed strip mills were built to take care of large orders of one size, automobile body steel being the outstanding example. The new plan, which, in effect, applies assembly line methods to the shipbuilding program, enables the maritime commission to take advantage of this facility.

Heretofore, only about 10 per cent of the steel plate required for the Liberty Ships (EC-2 vessels, officially) has come from strip mills. Under the new program 80 or perhaps 90 per cent will be strip mill plate.

The new combined bill of materials and the ordering program will govern on approximately 770 new ships for

Even in Winter Hot Spots Slow Up Production . .

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 inch sizes.

Keep Workmen Cool with TRUFLO FANS

During even the coldest weather there are "hot spots" in many mills—places where heat and foul air play hob with production.

Truflo Fans can keep your men on their toes all year around. All Truflo Fans are designed and built to put fresh, cool air exactly where it is needed. Perfectly balanced blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

There is a type of Truflo Fan for every cooling and ventilating use. Write for literature on any of the following kinds:

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Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

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which no material has, as yet, been ordered or scheduled.

Tonnage for the maritime commission is the largest item for steel plates in the entire war program and the Liberty Ship schedule represents more than half the commission's requirements. The working out of this arrangement is expected to ease a part of the burden on sheared plate mills which have been faced with a war demand far beyond their capacity to produce. The plan will not free steel plate for civilian use, but will make possible the fulfillment of essential war orders.

SKID PLATFORMS OF WOODEN CONSTRUCTION

▲ It can truthfully be said that out of every crisis there arises some good. For example, take the current rationing of steel.

Among the thousands of products threatened were skid platforms. With this factor as a spur, and even more stringent restrictions in the offing, the engineers of the Yale and Towne Manufacturing Company, Philadelphia, perfected an idea that they had been working on for some time.

It's a platform called the Timber-Lock—a platform that by virtue of its new and unique design uses no steel in the frame yet gives all the strength inherent in steel welding.

The Timber-Lock is made of specially selected tough oak—and is so constructed as to practically defy breakage. A good part of this strength is traceable to a new interlocking "wood-weld" process developed by Yale engineers to tie supporting leg runners and deck boards into one virtually inseparable unit.

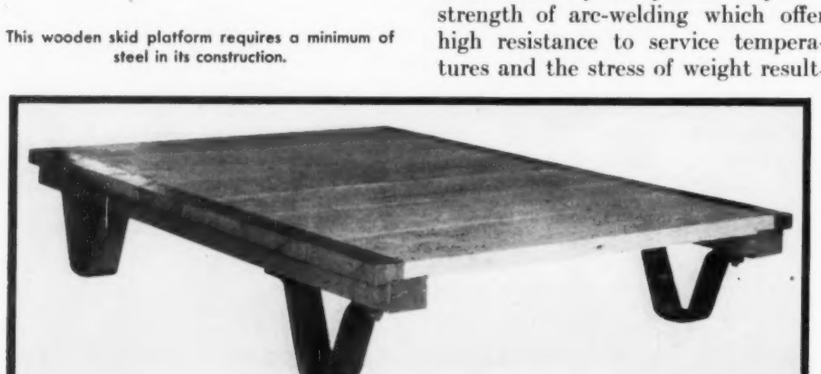
Instead of just placing the platform deck on the supporting leg runners and nailing—deep cut grooves run along the entire length of the platform deck boards. Into each of these grooves, the supporting hard oak leg beam is tightly fitted—thus interlocking platform and beams in a vise-like grip that completely eliminates rocking, shaking and other forms of instability.

Nor is this all. To further insure this one-piece rigidity, beam and deck are bound together with specially cement coated, spiralled helical nails, binding platform and beams at double rowed 1 in. alternate intervals along the entire platform length.

Legs are of the highest grade formed steel bars, joined to the leg beam by heavy forged steel bolts. Washers on top and bottom of the bolts guarantee rigid clamp. Also, the large diameter steel washer under leg bolt heads provides wide bearing point and insures increased leg stability.

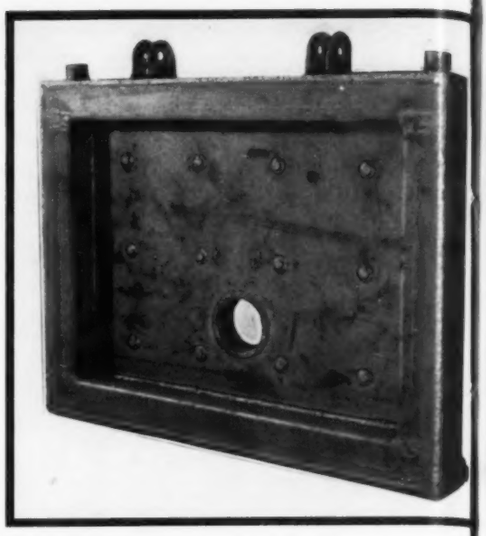
The Timber-Lock is available in all standard widths and lengths, plain or armored end. Also, vertical or standard leg design; four or six leg construction.

This wooden skid platform requires a minimum of steel in its construction.



WATER-LINED FURNACE DOORS ARC-WELDED

▲ One of the newer uses of electric arc welding in steel mills, in keeping with today's growing need for better maintenance of equipment, is for building water-cooled open hearth furnace doors and door frames. Fabricating such doors with their intricate water circulating systems, this modern process is found to be faster as well as less costly than with the earlier method of joining metals. Also, their efficiency in actual service is increased by the permanency and strength of arc-welding which offer high resistance to service temperatures and the stress of weight resulting from packing the doors with fire bricks. While intake water temperature is approximately 80 F and discharge water runs between 130 and 140 F, the radiated temperature against the inside of the door is about 3,000 F.



Arc-welding is a speedy and economical method of fabrication for water-cooled furnace doors.

All-important in this arc welding application is using the proper electrodes, cautions Harnischfeger Corporation, manufacturers of P & H electrodes, and whose constant research efforts have contributed much to advancement of welding. A heavily coated, quick-solidifying electrode with small spatter is necessary to overcome the difficulties in welding irregular joints and the poor and imperfect fit of adjoining metal sections in set-ups such as this. The furnace doors illustrated were built entirely by arc welding using "PF" electrodes which are suitable for single or multiple pass welding on mild steel. Readers desiring complete procedure are invited to write Harnischfeger Corporation, Welding Division, Milwaukee, Wisconsin.

EXTENDS LINE OF SMALL TRANSFORMERS

▲ For operating 115-volt devices from 230, 460 or 575 volt power circuits, Jefferson Electric Company of Bellwood, Illinois, has extended its indoor air-cooled power circuit transformers to include capacities from 25 to 150 va, inclusive. They are de-

signed to provide 115 volts for operation of lighting circuits, individual lighting for machine tools, welding machines, and other production machinery, and for 115 volt electrical devices such as small motor-driven equipment, magnets, controls, relays and the like. Their use makes unnecessary the installation of complete, low-voltage systems, saves copper, conduit, installation time and reduces costs. These transformers are self-contained, equipped with roomy wiring compartment for primary and secondary connections, thoroughly insulated for safety. They are listed as standard by Underwriters' Laboratories, Inc. Where lower voltage lamps are employed on machines, Jefferson transformers with 32-volt secondaries are available.

Transformers of this type are used to provide 115 volts for operation of small lighting systems, auxiliaries, controls, relays, etc.

NEW RUST INHIBITOR FOR BLACK IRON

▲ The Watson-Standard Company of Pittsburgh, Pennsylvania, announces the development of a new organic coating for black iron which they claim can be applied very economically at the steel mill and will result in the solution of many of the coating man's problems.

This is used as a protective coating in lieu of the oil previously used on the metal.

This new product is of the oxidizing type. It provides exceptionally fine protection against corrosion and serves as a prime coat for all types of synthetic and oleo-resinous coatings. It will withstand all the usual tests and should be a boon to those who have formerly used tin plate.

SEEKS METALLURGISTS FOR GOVERNMENT WORK

▲ The Civil Service Commission is seeking metallurgists for work in Government navy yards, arsenals, and other war agencies. The positions pay from $2000 to $5600 a year and will last in most cases for the duration of the war. Sending application forms, obtainable in any first- or second-class post office, to the Commission in Washington, D. C., is all that is necessary to be considered for these positions.

Experience in metal working industries with fabrication processes such as welding, die-casting, heat treating, x-ray testing, and metallographic work is particularly desired, but not necessary for all positions. College training in metallurgy or college training in other subjects and one year's experience in metallurgy will qualify

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. . . look to the modern tin stacks. They are equipped with Kemp Immersion Melting.

For Speed — Minimum Dross Formation—and Top Quality in tin plate manufacture, write **The C. M. Kemp Manufacturing Co., 405 East Oliver St., Baltimore, Maryland.**

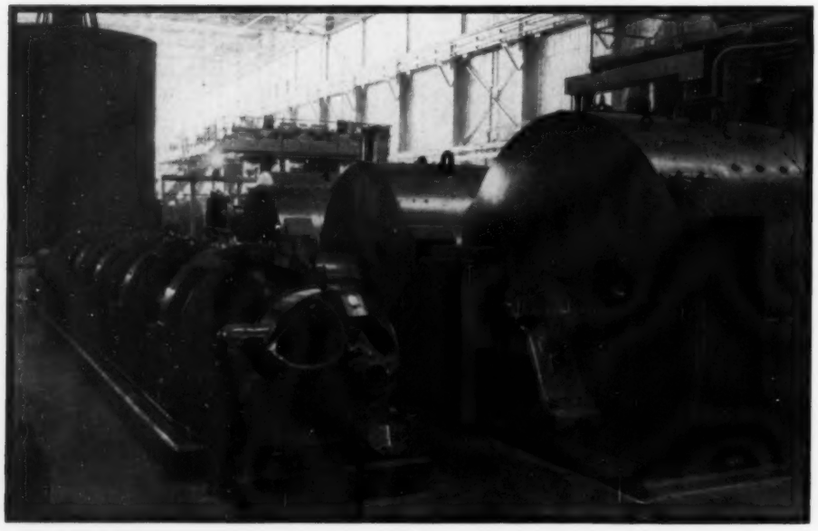
KEMP of BALTIMORE

for positions paying $2000 a year. For the higher salaried positions, some industrial experience, or graduate study, in addition to a bachelor's degree, is required. The positions are in Washington, D. C., and in Government war establishments throughout the country.

COLD MILL FEATURES IMPROVED CONTROL

▲ To roll intermediate gauge enameling and galvanizing sheets a recent installation of a 54 in. four-stand tandem cold reduction strip mill has been made at a southern Ohio plant. The electrical equipment for this mill incorporates improvements to enable faster acceleration, more uniform tension control, and reduction in off-gauge strip. Normal operation speeds are about 2100 fpm. Pictured at the right are the four 750 volt Westinghouse mill motors, powered by a 7000 kw main power synchronous motor generator set. At the left, is a nine-unit auxiliary motor generator set, consisting of a series booster generator for IR drop compensation of each mill motor, reel motor booster generator, three exciter units for excitation of the mill motors, main generators, synchronous motors, and 600 hp, 440 volt, 1200 rpm synchronous driving motor.

These motors and generators are used to drive and control a 54 in. four-stand cold reduction strip mill.



TRUCKS IMPROVE CAR LOADING PRACTICE

▲ The Pequanoc Rubber Company, Butler, New Jersey, manufacturers of rubber sheets, cuts time of box-car loadings in half, conserves man power and receives a 150 per cent return in the first year of operation of its 2000-lb capacity Baker fork truck. Mr. T. Mace, superintendent of the company writes, "Eight months after we placed the Baker fork truck in service in our plant, our savings had paid for the original investment."

Rubber sheets formerly handled with 4-wheel hand trucks had to be loaded and unloaded singly for storage or shipment. When the sheets came off the rolls they were placed on a hand truck and it was necessary to wheel the truck several hundred feet to the warehouse where the sheets were taken off one at a time and piled on the floor for storage. When they were shipped it was necessary to again take the sheets one by one and place them on a hand truck, move them to the highway truck or box-car and again re-handle them. This procedure took considerable time and was costly.

Present procedure is to load the sheets as they come from the rolls on pallets which are picked up by the Baker fork truck, carried to the warehouse, and stored two high on the pallets. When the sheets are ready for shipment the Baker truck goes into the warehouse, picks up a pallet load of rubber and carries the pallet loads right into the box-car and places them in position, two high. The ultimate customer also saves time and expense by removing the pallet loads from the box-car with his own power truck equipment.

This electric truck showed remarkable results in the economical loading of box-cars.

One of the most important things any company can do at the present time to cooperate in the war program is to release man power. The Pequanoc Rubber Company is doing this since one man with the Baker truck loads a box-car in less than half the time formerly required by six men. In addition to this important advantage, the company paid for its power truck equipment in eight months and from that time on has continued to save money.

ANNOUNCES NEW DE-TINNING PROCESS

▲ A process for recovering tin and steel from used tin cans, requiring no preparation of the cans on the part of the householder, or other users of canned commodities, can now be applied to large scale production, according to an announcement by Walton S. Smith, Vice President of the Metal and Thermit Corporation. This company has been operating a test plant at San Francisco for the last five years.

"The pilot plant is a complete unit with a capacity of over 6000 tons. From its operations, suitable methods have been worked out for the recovery of about 24 pounds of tin oxide and

almost a ton of scrap steel per ton of discarded cans," Mr. Smith stated. "The tin oxide is readily smelted to a grade equivalent to Straits Tin. This is the grade of tin formerly secured from the Malay Peninsula, now in Japanese hands."

The San Francisco plant handles cans which are collected from the city of Oakland and nearby communities. It accepts empties just as discarded and does not require special preparation for collection. The processing unit comprises unloading equipment, inspection station, rotary screens for dirt removal, incinerator for charring cans to destroy fat, paper, lacquer and other combustibles and to separate the carbonaceous residue, shredding and pre-washing equipment, storage facilities, and complete equipment for continuous detinning by the alkali process.

Rough estimates indicate that about 2,500,000 tons of tin cans are discarded annually in this country and that about 1,000,000 tons of these could be economically collected and detinned, yielding about 11,000 tons of tin and 900,000 tons of scrap steel.

Detinning of tin plate clippings obtained from can companies and other sources has been a well established industry for more than thirty years, but detinning of used cans has been impractical in peace times. Normally prices of both tin and steel scrap are comparatively low. Ordinarily, residual tin in scrap derived from cans is objectionable to steel mills. However, with imported tin no longer available and the present shortage of steel scrap, the usual objections do not hold and the used container can provide a source of worthwhile quantities of both metals.

The principal problems involved are those of collection, preparation and transportation of cans.

In areas where cans are to be collected for detinning, the cans would have to be kept separate from other refuse. It would also be advisable to shred the cans at collection centers so as to reduce their bulk for shipment to the plants. Location of plants of about 50,000 to 80,000 tons capacity near large centers of population appears the most practical solution to the transportation problem.

Announced plans to reduce by forty per cent the amount of tin going into containers would eventually reduce the amount of tin that could be recovered, but not for a year or two. In any event, the black sheet steel, which it is said will be substituted for tin plate in many of its present uses, could be reclaimed.

BLAST FURNACE SETS PRODUCTION RECORD

▲ A new world's record for blast furnace production was established by the No. 3 Carrie Blast Furnace of Carnegie-Illinois Steel Corporation, United States Steel subsidiary, when a total of 41,782 net tons of pig iron were produced during the month of January. The performance of Carrie Furnace, which is located at Rankin, Pennsylvania, shattered a previous all-time record of 41,701 net tons established by Carnegie-Illinois' No. 10 Furnace at Gary, Indiana, Steel Works in July, 1931.

The importance of the record is demonstrated by the fact that enough pig iron was produced by the Carrie Furnace in the month of January,

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of the De Laval-IMO Oil Pump are the power and idler rotors, which run in perfect rotational and hydraulic balance. The pump, therefore, operates at standard motor and turbine speeds without vibration. Delivery is uniform and without pulsation, as from a steadily advancing piston. The IMO pump handles any volume of any oil against any pressure.
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Steel Mill
PLATE STAMPING
Slab section and sheared plate identification is rapidly stamped with Matthews Plate Stamping Holders. Of tool steel construction, they are light in weight and very durable. Easy to handle! The "Shepherd-Hook" holding device eliminates "wrong - side - up" stamps. Stamps cannot fall out or fly out on rebound from hammer blows. Safe, rapid and definite stamping.
Steel stamps are held in place by a properly tempered "Shepherd-Hook." They are quickly and easily changed. Holders are made for any required quantity of stamps. Write for literature and prices. State character size and number of characters to be stamped.
Same holder made for marking pipe, rounds, etc.
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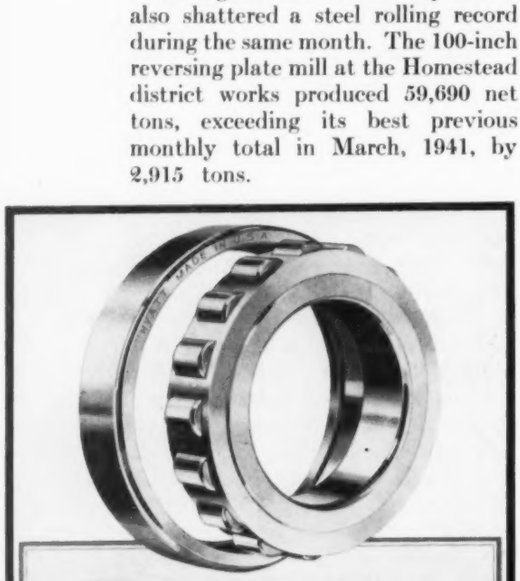
3942 FORBES ST. ∴ PITTSBURGH, PA.
New York—Chicago—Phila—Boston—Detroit—Newark—Syracuse
DISTRICT SALES OFFICES - CLEVELAND - HARTFORD - BIRMINGHAM

which, when converted into implements of war, is the equivalent of 1,635 medium tanks, or 23 destroyers, or one complete modern battleship.

Carnegie-Illinois Steel Corporation also shattered a steel rolling record during the same month. The 100-inch reversing plate mill at the Homestead district works produced 59,690 net tons, exceeding its best previous monthly total in March, 1941, by 2,915 tons.



How engineering, metallurgical and manufacturing science over a half century have met industry's anti-friction bearing demands for higher capacity in smaller space is pictured by the Hyatt Bearings Division, General Motors Corporation, on their Fiftieth Anniversary. The first roller bearing built in 1892 by the inventor John Wesley Hyatt, with its helically wound rollers assembled loosely in a half cage, was a major contribution in its day. But what a contrast with a precision Hyatt Roller Bearing of 1942 as used in army and navy aircraft, with many times the capacity of its prototype and held to tolerances and uniformity of size undreamed of fifty years ago.

TO CONSTRUCT MILLION DOLLAR BOILERHOUSE

▲ Construction will begin shortly on a $1,000,000 boiler house for the Youngstown Sheet and Tube Company at South Chicago, Illinois, it was announced recently by the Rust Engineering Company, of Pittsburgh, Pennsylvania, the contractors.

The new installation, consisting of three high-pressure boilers, will replace existing facilities which were built shortly after 1900 for the old Iroquois Iron Company. The plant is located on the Calumet River, where it flows into Lake Michigan.

MOTOR DESIGNED FOR GREATER PROTECTION

▲ "The greatest motor improvement in years" is how Allis-Chalmers describes the "safety-circle" protection of its new Lo-Maintenance motors. Specially developed to give the motor complete all-around protection, the "safety-circle" is a wide, solid rib—integrally cast as part of the frame—which forms an unbroken circle of protection around the stator.

All the experience of building motors for over fifty years has been concentrated in the development of this advanced product. One-piece cast frame and cast end-shields guard the motor from exterior knocks and abuse. A more liberal use of electrical materials makes this motor internally and electrically stronger because current and magnetic densities are less extreme. Improved bearing design delivers smoother performance with full-flow lubrication and easier maintenance. Additional cross strength has been built into the distortionless

The wide, solid rib, cast as part of the frame, forms an unbroken circle of protection around the stator of this motor.

stator for maximum power efficiency. Rotor is keyed to the shaft for strength, and its outer surface is turned for smoothness and an accurate air-gap. Other Lo-Maintenance features are oil drains at bottom of bearings for easy flushing, removable end-pieces, and large conduit box for handy wiring.

CLAIMS RECORD ON RELINING FURNACE

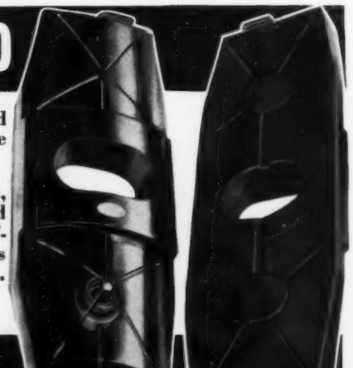
▲ What is believed to be a world record for speed in relining a blast furnace was announced recently by Columbia Steel Company, subsidiary of United States Steel Corporation. The record, 31 days for the complete job, was established at the Ironton Blast Furnace operating near Provo,

BEARING BOTTLENECKS ELIMINATED

GATKE Moulded Fabric Bearings have proved that delays can be avoided and costly machine shop work eliminated.

From the largest, to the smallest roll necks, table rolls, Universal Couplings, Cranes and other tough service—GATKE Bearings are effecting improvements that are so tremendous they must be experienced for full appreciation.

Particulars on request.



GATKE CORPORATION - 228 N. La Salle - CHICAGO

Utah, and knocks some 20 days off records previously established by eastern plants.

According to Columbia officials, the record is even more unusual because the job was tackled from a standing start, in mid-winter and in a locality remote from large steel operations. The Ironton Furnace is the only blast furnace operating west of the Rocky Mountains.

On January 16, because of a "break out" through the hearth jacket, it was necessary to blow out the furnace to reline. With the urgent need for all-out defense production, C. T. Keigley, general superintendent of Ironton Works, realized that the furnace should be relined in minimum time due to the necessity of replacing part of the hearth's jacket before brick laying could be started. On January 19, the furnace crew pitched in to remove the old brick lining. On January 29, the new lining was started and on completion of brick work in the hearth, heat was immediately applied to dry out the bottom of the furnace as the brick layers continued laying bricks to the top. The relining was completed on February 11. Scaffolds were removed immediately and a drying fire started in the furnace. After five days of drying, the furnace was blown in February 17, with just 31 days elapsing between blowing out and blowing in.

In 1937, the Ironton Furnace was last relined in an over-all time of 64 days. In as much as the furnace has been operating during the past six months on an average production of 660 tons a day, the record relining job means that 33 days output of pig iron, amounting to some 21,780 tons, will be made available to national defense. This saved production of pig iron, together with its ordinary complement of scrap, is enough to produce 44,100 tons of finished steel, the equivalent of the tonnage required to build approximately 40 destroyers.

JONES & LAUGHLIN ABSORBS OTIS STEEL

▲ A contract for the purchase of the Otis Steel Company of Cleveland was announced by H. E. Lewis, president of Jones and Laughlin Steel Corporation, in a letter to stockholders accompanying the annual report. The contract is subject to approval of the Otis shareholders at a special meeting on April 24th.

Under terms of the contract Jones and Laughlin will acquire the business, property and practically all of the assets of Otis and assume all its liabilities, including $13,063,000 of outstanding 4½ per cent first mortgage bonds, due 1962.

The desirability of acquiring the Otis properties was stressed by Mr. Lewis who said Jones and Laughlin will issue to Otis 34,293 shares of its 5 per cent Series "A" preferred stock, 34,293 shares of its 5 per cent convertible Series "B" preferred stock, 366,306 shares of its no par common stock and the sum of $916,536 in cash. These securities and cash will be distributed to Otis stockholders under the Otis plan of distribution.

There will be considerable benefit to the Jones and Laughlin Steel Corporation from the purchase. Mr. Lewis pointed out that with all of its steel-making capacity located exclusively in the Pittsburgh district, Jones and Laughlin is at a considerable dis-

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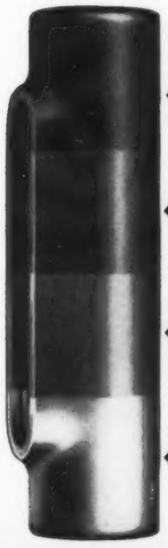
3 FINISH

Crouse-Hinds modern plating methods provide assurance of the best finish.



CONDULETS—The Standard of Quality in the field of electrical conduit fittings.

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U. S. A.

Sales Offices: Birmingham — Boston — Chicago — Cincinnati — Cleveland — Dallas — Detroit — Houston — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington
Resident Salesmen: Albany — Atlanta — Baltimore — Buffalo — Charlotte — Denver — Louisville — New Orleans
CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

advantage with competitors having plants in two or more strategic locations.

Mr. Lewis stated it was contemplated that Mr. E. J. Kulas, president of Otis, would be elected a member of the Board of Directors of Jones and Laughlin and vice charman of the Executive Committee and be associated in the active management of the company.

The acquisition of Otis, it was said, will give Jones and Laughlin an operation and shipping point in the Cleveland district, located with access to the Great Lakes shipping facilities, making possible an advantageous assembly of raw materials in the Cleveland district and more ready entry to many markets.

The advantages of diversified plant locations were said to make possible the shipment of products from points most economically located to service the destination points involved, and the elimination of substantial costly cross hauling.

Jones and Laughlin in its December 31, 1941, balance sheet shows total assets of $258,944,873, while Otis as of the same date had total assets of $38,866,865.

AIR CONDITIONING INCREASES PRODUCTION

▲ Air conditioning, credited with increasing production in the iron and steel industry by as much as 27 per cent per blast furnace, will be utilized to increase production of silvery pig iron, vital to machine tool and other war production, it has been announced by J. I. Lyle, president, Carrier Corporation.

This announcement followed the signing of a contract with the Jackson Iron and Steel Company, Jackson, Ohio, by Carrier for the air conditioning of one of the few high silicon content, or silvery pig iron, producing furnaces in the world.

This latest contract brings to 12 the number of blast furnaces already air conditioned or under contract, Mr. Lyle reported.

Three furnaces have been air condi-

DISCUSS WAR PROBLEMS AT SALES CONFERENCE

▲ Sales and production problems brought about by the tremendous war requirements for transmission products came in for careful study at a two day conference of the W. A. Jones Foundry and Machine Company national sales force and factory executives held at the Palmer House in Chicago on January 15th and 16th, 1942.

The place of the sales organization in rendering important services to the trade in connection with proper application and use of products as well as in checking deliveries was stressed at the conference.

Convert WASTE into WEAPONS with PLANNED LIGHTING

The amount and excellence of armament production rises with the availability of man power, critical materials and electrical power. You will increase war production in your own plant when you:

• Conserve MAN POWER:

Create the seeing conditions that mean less man hours per given task, less accidents and errors, less strain on eyes and nerves.

• Conserve MATERIALS:

Specify lighting units which use a minimum of critical metals in their construction.

• Conserve ELECTRICITY:

Install lighting equipment that provides maximum light *on the critical working areas* with minimum current consumption.

• • •

Industrial lighting specifications are as varied as working conditions from plant to plant. Our engineering department knows that the only *right* solution to your lighting problem must be based on *your* plant layout and *your* production requirements. Our engineering assistance, available entirely without cost or obligation, is predicated on this certainty.

WRITE TODAY FOR PRACTICAL DATA

BETTER LIGHT BETTER SIGHT GREATER SPEED

Holophane COMPANY, INC. SINCE 1898

342 MADISON AVENUE NEW YORK CITY

THE HOLOPHANE CO. LTD 345 YONGE ST. TORONTO, CAN.

tioned at the Woodward Iron Company, Birmingham, Alabama, where production increases have been reported as high as 27 per cent per furnace with a savings of as high as 13 per cent in coke.

Three installations have also been completed at Jones and Laughlin Steel Corporation, which reports production increases as high as 18 per cent with coke savings exceeding 5 per cent.

Four installations of Carrier equipment are now under way at Bethlehem Steel Company and air conditioning equipment is now in production at Syracuse for the Tata Iron and Steel Company, Ltd., at Jamshedpur, India, the largest steel mill in the British Empire.

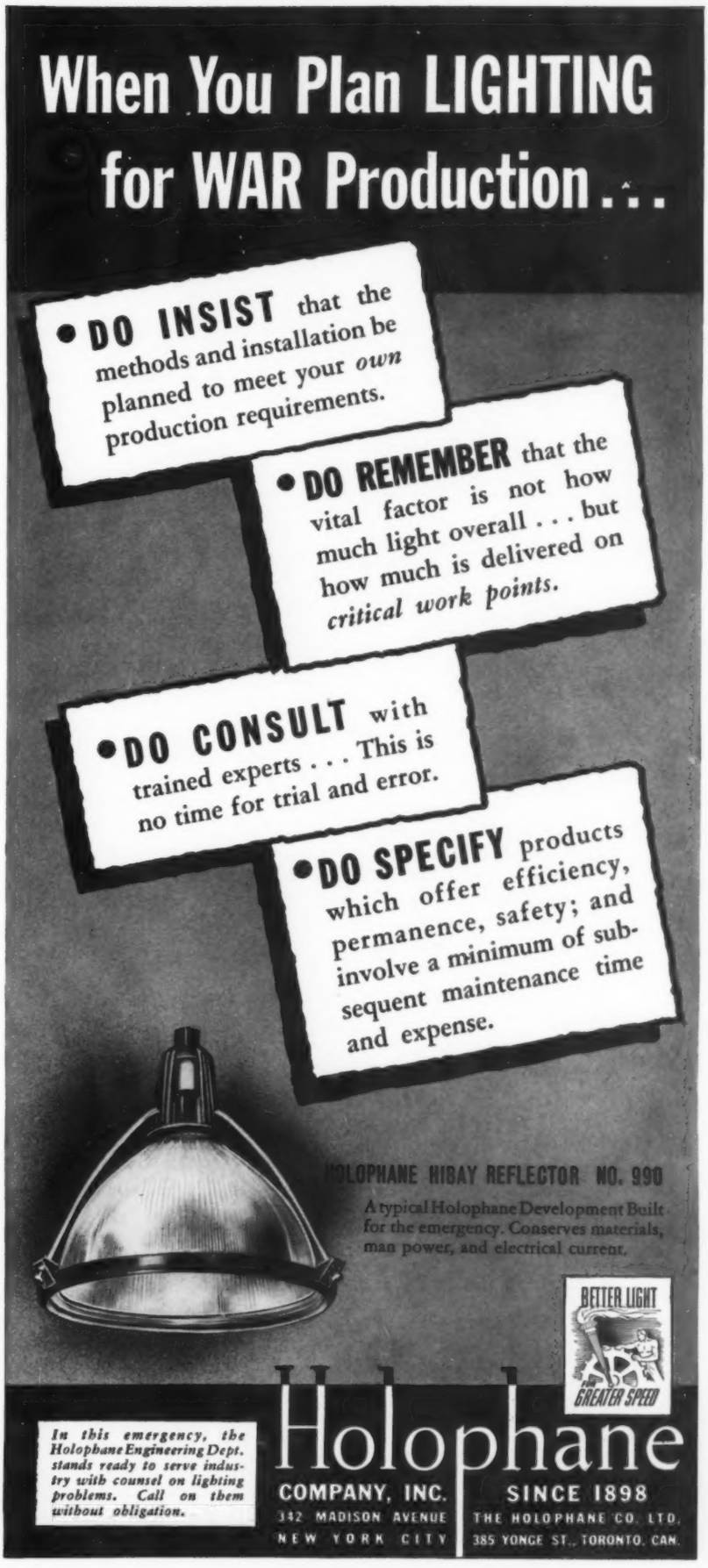
Air Conditioning equipment provides increased production of more uniform quality iron, according to Mr. Lyle, by removing as high as 30 tons of water per day from the 2,700 tons of air blown through the average size blast furnace every 24 hours.

Describing the importance of this installation to the war effort Mr. H. R. Shick, general manager of Jackson Iron and Steel Company said: "Silvery pig iron, containing 5 per cent to 17 per cent silicon in contrast to the low silicon content of basic iron, is used for special castings, many of which are in demand for the manufacture of machine tools. It is also used to help produce economical mixes for iron foundries and steel plants as a source of silicon, as a deoxidizing agent and to retard the oxidation of the other elements in the charge.

"In the production of silvery pig iron, coal as well as coke is used in charging the furnace.

"Air conditioning equipment to be furnished by Carrier consists of a centrifugal turbine-driven refrigeration machine of 300-ton cooling capacity, a spray type dehumidifier and a cooling tower.

"The air conditioning system used in the Jackson furnace will be 'precompression refrigerated dry blast', under which the air is dehumidified by cold water sprays before delivery under pressure into the furnace." Because the air is cooled and thus contracts, a greater volume of air can be blown into the furnace at less cost for fuel, Carrier engineers point out. Often, they declare, the savings in fuel used in the blowing engine alone are sufficient to cover the costs of operating the air conditioning equipment.


When You Plan LIGHTING for WAR Production...
• DO INSIST that the methods and installation be planned to meet your own production requirements.
• DO REMEMBER that the vital factor is not how much light overall . . . but how much is delivered on critical work points.
• DO CONSULT with trained experts . . . This is no time for trial and error.
• DO SPECIFY products which offer efficiency, permanence, safety; and involve a minimum of subsequent maintenance time and expense.
HOLOPHANE HIBAY REFLECTOR NO. 990
A typical Holophane Development Built for the emergency. Conserves materials, man power, and electrical current.
BETTER LIGHT for GREATER SPEED
In this emergency, the Holophane Engineering Dept. stands ready to serve industry with counsel on lighting problems. Call on them without obligation.
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FIBER INDUSTRIAL BRUSH WILL SPEED WAR WORK

▲ A new type of Tampico fiber industrial brush, treated by a secret process, has been announced by the Osborn Manufacturing Company, Cleveland, Ohio, the world's largest manufacturers of industrial brushes. The new product is expected to speed war production in many industries, including automotive, aircraft, shipbuilding and any other requiring brushing equipment to remove burrs, polish or form metal parts, or to finish welded seams.

Used with the proper abrasives, according to the company's engineers, the new product, called the Osborn Fascut Treated Tampico Section, will remove tool marks from aircraft motor parts, such as connecting rods, tappets, cams, etc. Another application of the section is the slight rounding of corners of different motor parts, gear teeth and similar products.

The new brush will remove burrs without damage, when used without abrasives, from metals such as aluminum and Alclad, whereas a wire brush is likely to scratch, according to engineers of the company.

Announcement of the new product followed discovery of the fact that the material used in the treatment spaces the fibers to a definite relationship, one with the other, and eliminates the tendency of the fiber to group or "knife" at high speeds.

Osborn engineers claim that the new treatment supports the individual strands of Tampico, thus preventing it from fluttering and throwing off the compound. The new brush is of longer life and holds abrasives better. It resists heat and temperature changes more effectively.

Individual brushes are widely used in the defense industries and play a vital role in the construction of aircraft, tanks, ships, and other armaments.

The brushes are available in diameters of 4, 6, 8, 10, 12, 14, 15, and 16 inches.

For emergency motor repairs

Use this fast air drying Insulating Varnish

Today, more than ever before, it is vitally important that electrical equipment breakdowns be repaired and units returned to service as quickly as possible.

Naturally you want the protection a baking insulating varnish such as CHINALAK will afford motor windings but when units are too large to be handled conveniently in baking ovens or time out must be held to a minimum use DOLPH'S ND-17 Black Oilproof Air Drying Varnish.

ND-17 provides dependable protection for windings when baking is not permissible. This varnish is outstanding because it provides a higher degree of flexibility, oilproofness and longer life than most air drying varnishes. Of particular interest to the steel industry is its excellent resistance to water and acid attack.

Your electrical repair department has a definite need for a material with these outstanding characteristics. If you will send us the name of your electrical maintenance engineer we will furnish him with complete information on this time saving varnish.

Dolph's **JOHN C. DOLPH COMPANY**

Insulating Varnish Specialists

166A EMMETT ST. NEWARK, N. J.

UNITED ENGINEERING HAS RECORD BACKLOG

▲ United Engineering and Foundry Company reports that while many records were established in its 1941 operations, including a record volume of sales, an accompanying increase in taxes had its effect upon the company's financial results, with net earnings lower than in 1940.

George T. Ladd, president, in presenting the annual report to stockholders, said "our backlog of unfilled orders is substantially in excess of any time in our history, requiring a constant and continuous production effort beyond the end of 1942. To meet existing requirements, continuous operations are being maintained on a seven-day week schedule. The company is using its full capacity in an all-out aid in the present emergency."

Net earnings for the year ended December 31, 1941, were $3,309,297 equal, after preferred dividends, to $3.96 per share of common stock outstanding, compared with $3,724,460, or $4.47 per common share, in 1940. Mr. Ladd said local, state and Federal taxes, in the amount of $4,667,000,

were almost double those of the previous year, and were equivalent to 59 per cent of the company's total earnings before their deduction.

The company has expended and appropriated substantial amounts for emergency buildings in the effort to meet production demands. All of this expenditure is expected to be charged off during the emergency period.

In connection with the company's custom to report on some of the outstanding engineering developments in the machinery field during the year, Mr. Ladd said excursions into the strip processing field have resulted in semi-continuous pickling lines, strip galvanized equipment, and now more recently in electrolytic strip tin plate installations, "all of which bid fair to retain post-war importance." The company's activities also have been utilized in many special developments of more conventional mill equipment to accomplish emergency objectives.

Investments in companies in other countries previously had been written down to nominal values and there was no change in this connection during the past year.

At December 31, 1941, the company had cash of $4,052,387, total current assets of $12,639,215 and total current liabilities of $6,337,301. A year earlier, cash was $5,476,839, total current assets were $10,041,068 and total current liabilities $3,768,692.

STEEL PLATE SHIPMENTS REACH NEW PEAK

▲ February shipments of steel plates established a new monthly record despite the shortness of the month, C. E. Adams, chief of the Iron and Steel Branch, announced.

February shipments totaled 758,723 tons as compared to 754,522 in January. Strip mills produced 268,988 tons of plate in February, a gain of 18,000 tons.

Shipments of plate for the merchant shipbuilding program increased 15 per cent in February, Mr. Adams said. He expects the March total to exceed 800,000 tons.

GOVERNMENT SHIPPING IDLE FURNACE TO MEXICO

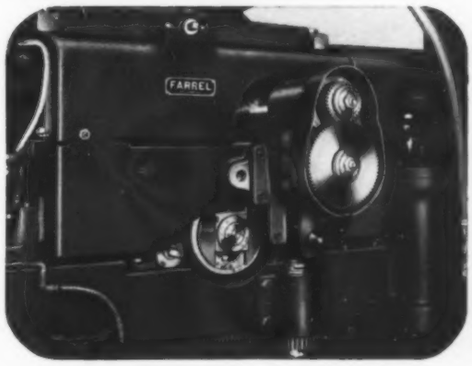
▲ Idle since 1926, a blast furnace of the bankrupt Mississippi Valley Iron Company has been requisitioned by the United States government for shipment to Mexico City, E. Field Goltra, president of the company, said today. The requisition designated the American Rolling Mill Company as agent in the transaction. A price for the property will be fixed by government appraisers. Goltra said a furnace of this sort, ready for production, would be worth about $2,000,000. It has daily capacity of 350 tons of pig iron.

PUMP CATALOG OFFERED

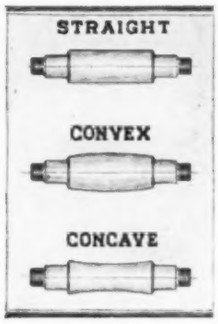
▲ Practical information concerning pump adaptation for a wide range of duties under varying conditions is the theme of the new industrial catalog just published by Pomona Pump Company.

A free copy will be supplied by calling or writing Pomona Pump Company, 206 East Commercial Street, Pomona, California.

Accurate Roll Contour Assured by . . . .



Crowning and Concaving Device of FARREL ROLL GRINDERS



The Farrel Crowning and Concaving Attachment automatically controls roll shape and produces the exact curvature required. Straight, convex or concave contours are ground to exact symmetry and accuracy.

●

For complete information write for copy of Bulletin No. 111.

The precise construction of every feature of the Farrel Heavy Duty Roll Grinder is based upon the principle of "maximum transfer of skill to mechanism."

The patented Farrel crowning and concaving mechanism, with which Farrel Roll Grinders are equipped, produces a mathematically accurate curve of correct shape for a crowned or concaved roll exactly symmetrical on both halves of the roll. The same setting invariably produces precisely the same contour, which permits fixed uniformity in all rolls.

The mechanism is the adjustable, single eccentric type, readily accessible so that settings for any curve can be made quickly. Its built-in location on the rear of the carriage gives firm support to the wheelhead and prevents any tendency to vibration at this point.

This and other features of the Farrel Heavy Duty Roll Grinder provide assured control of roll accuracy and finish to predetermined standards, and reduce dependence upon the skill of the operator to a minimum. "Production with Precision" is built into every individual part of the Farrel Roll Grinder.

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

PITTSBURGH STEEL COMPANY WILL ADD BLAST FURNACE

▲ Pittsburgh Steel Company has entered into a lease agreement with the Defense Plant Corporation for the construction of an additional blast furnace which will have a capacity of 432,000 tons per year, it is disclosed in the annual report. An announcement that such negotiations were being carried on had been published previously.

When this new furnace is placed in operation, the scrap condition will be relieved to a great extent, it was said.

Henry A. Roemer, chairman and Joseph H. Carter, president said another lease was made with the DPC for new facilities for the manufacture of certain types of seamless tubes needed in the defense program and "several addditional projects to further the Government's program of greater steel production are now in the process of discussion of negotiation with the WPB and the DPC."

ALL THIS at a single glance

1. RATE OF AIR FLOW
2. RATE OF FUEL FLOW
3. RATIO OF AIR TO FUEL OR PERCENTAGE OF AIR EXCESS OR DEFICIENCY

USED on multiple zone slab heating furnaces, for instance, to secure maximum heating rate and efficiency of fuel consumption at the same time making possible the control of the furnace atmosphere to be oxiding (excess of air) or reducing (deficiency of air) as dictated by the requirements.

Many other uses in steel mills, gas producing plants, heat generating plants, CO_2 generating plants, sewage plants, chemical plants, kilns, air conditioning—any place where there exists a relation between any two of the following functions: flow of gas or flow of oil or other measurable fluids; pressure, draft, suction, temperature (up to 1000°F.) speed in r.p.m. or inches per minute, position, level and others.

The cross-pointer feature offers an ingenious method of revealing relationships not apparent in separate instruments or conventional scales. This distinct innovation is found only in Hays Visio Ratio Gage.

If you will write us, stating the condition, we will tell you exactly how the Hays Visio Ratio Gage can be applied to your problem.

Address us . . . . 960 Eighth Avenue, Michigan City, Ind.

The HAYS CORPORATION
SINCE 1903 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

Available Literature

▲ About a year ago the Federal Civil Service Commission began a recruiting drive for technologists. The number of persons on the employment lists now established is not sufficient for today's war-time needs. Accordingly, the Commission has recently reissued the announcement of these opportunities for Government employment with slightly modified requirements. Salaries for the positions range from $2,000 to $5,600 a year. Applications may be filed until further notice with the Commission's Washington office.

By technologist the Commission means a person experienced in "the necessary production, engineering, and scientific research work essential for the successful operation of an industrial plant, where such plant operation is based upon a thorough and expert knowledge of a branch of an applied science", such as explosives, fuels, plastics, rubber, minerals, or textiles.

For the Junior positions ($2,000 a year), applicants will no longer have to take a written test, and, as before, no written test will be given for the higher positions. The maximum age limit for all the grades has been raised to 60 years.

Copies of the announcement (No. 188), and the forms for applying, may be obtained at first- and second-class post offices, or from the Civil Service Commission, Washington, D. C.

▲ A newly designed unit for the manual control of remote valves, dampers and other pneumatically operated equipment is announced by the Foxboro Company. In appearance, the unit harmonizes with the rectangular case in which Foxboro recording and controlling instruments are now available. When the unit is flush-mounted, its front surface is only 3/16 in. from the surface of the instrument panel, and as its setting knob and pressure indicator are recessed, there are no protruding parts to suffer accidental bumps.

Specifically designed for dead-end service, the remote valve control unit will hold reduced pressures, dependably, to values within very narrow limits. Although most commonly

(*Please turn to page 115.*)

For Rolling Shell and Other Rounds

You need

"Techni"

PROCESS ALLOY STEEL ROLLS

The Rolls With The Red Wabblers
They Roll More Tons Per Dressing

"TECHNI" Process Alloy Rolls have great strength, excellent finish, unusual wearing quality, resistance to slippage and are anti-fire cracking. These extra qualities you get with rolls are made possible by the "TECHNI" Process, an exclusive development of Mackintosh-Hemphill, which regulates the quality and grain size of the rolls with as much exactness as

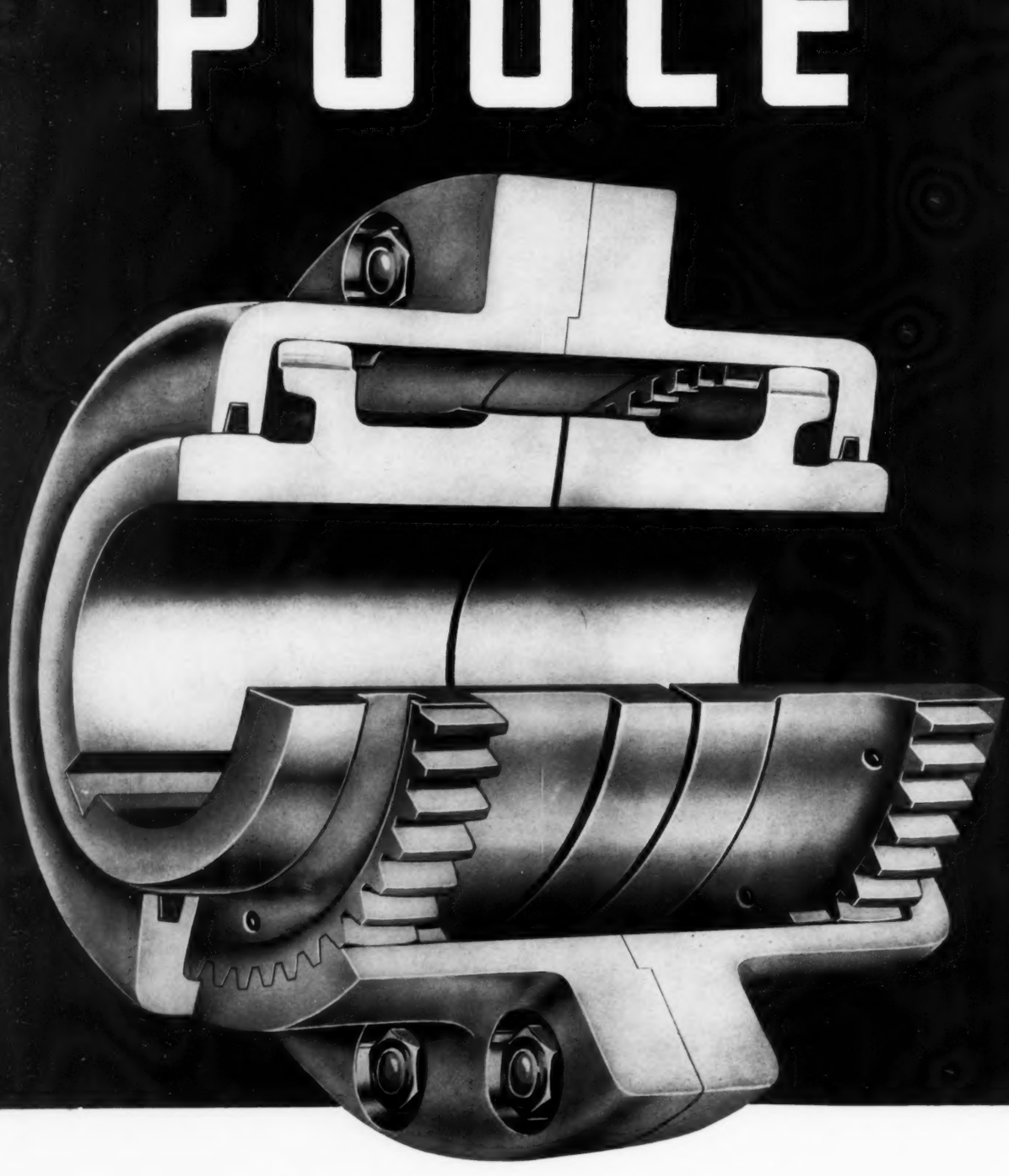
the best modern steel practice regulates the quality of steel . . . Make sure you get the best—order "TECHNI" Process Alloy Steel Rolls.

OTHER MACKINTOSH-HEMPHILL PRODUCTS: Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes

Since 1803—Pioneers, Engineers and Builders

MACKINTOSH-HEMPHILL COMPANY . . . Pittsburgh and Midland, Pennsylvania

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

(*Continued from page 112*)
used as its name suggests, it is equally useful in other applications, such as the setting of the control points of distant instruments or the adjustment of positioning or pressure-producing pistons, located in inaccessible points. It is practical for operation over distances as great as 1000 feet.

The unit is illustrated and fully described in Bulletin A-276 of the Foxboro Company, Foxboro, Massachusetts, of which copies will be sent on request.

▲ Conductivity and heat transfer charts, as well as other informative data, are included in the illustrated folder just issued by Johns-Manville on Superex block insulation for temperatures from 600 to 1900 F. Service recommendations and sketches suggestive of the many special shapes in which the material can be furnished, as well as a summary of its physical characteristics, are also included. One of the charts facilitates the selection of proper proportional thicknesses of Superex and 85 per cent Magnesia for various surface temperatures to provide a combination insulation for maximum insulating efficiency.

Copies of the folder, Form IN-101A, may be secured from Johns-Manville, 22 East 40th Street, New York, New York.

TAP CHANGER FEATURES SILVER TO SILVER CONTACTS

▲ Retaining the fundamental and highly desirable principles of straight line movement, Pennsylvania Transformer Company of Pittsburgh, Pennsylvania, has introduced favorable improvements in its tap changer for power transformers.

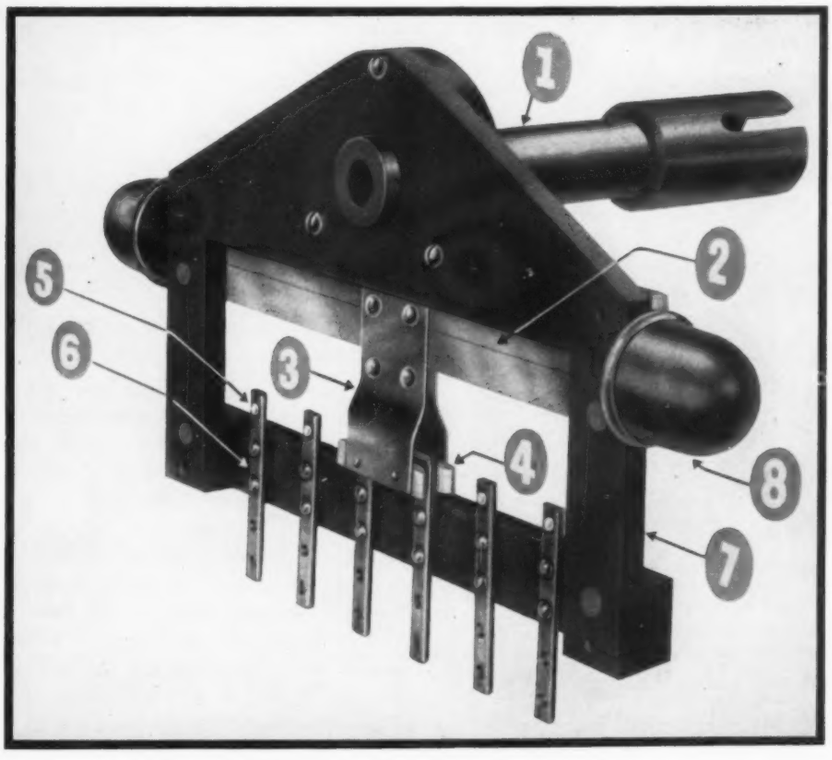
This new tap changer featuring silver to silver contacts, is capable of carrying heavy overload without over-heating and is able to withstand "dead" short circuits without detrimental effects.

Tests have been made to fully prove these characteristics.

Its method of operation as depicted in the accompanying illustration is as follows: The insulating shaft (1) carries on its end a steel gear, which is hidden from view. This gear engages a cadmium plated steel rack (2). The rack carries two self-adjusting and self-aligning steel springs (3). On the end of each spring is mounted a copper jaw with silver inlays (4). The pressure of the spring is transmitted to the movable jaws which make contact by bearing against silver rivets (5) imbedded in stationary copper jaws (6). The transformer leads are bolted on to the stationary jaws.

The supporting frame (7) is fabricated of insulating material of great mechanical and electrical strength. Electrostatic shields (8) are provided on high voltage tap changers to eliminate corona.

The movable jaw, actuated by the rack and gear, travels in a straight line. No lost motion, no misalignment!



▲ A 58 page, completely revised catalog describing American "Dustube" dust collectors, both knock-down and assembled types, has just been published by American Foundry Equipment Company, 555 South Byrkit Street, Mishawaka, Indiana.

Prepared as a handy manual to serve plant engineers and officials in the selection of proper control equipment for specific dust problems, it provides full information and photographs of the models available with operating data, construction features and basic specifications of these high efficiency cloth bag type collectors.

A complete engineering manual section is included which gives practical essential data for efficient operation of a dust control system, technical layouts and engineering tables and charts especially useful in planning applications of dust control units.

The catalog is spiral bound and of standard 8½ x 11 in. size for convenience in filing as a reference manual.

Copies of catalog No. 72 may be obtained directly from the manufacturer.

▲ A clear, concise explanation of how the national defense program affects purchase, use and maintenance of temperature measuring and control instruments is given in defense bulletin No. 1, issued by Wheelco Instruments Company, Harrison and Peoria Streets, Chicago.

The bulletin, of six pages, has been issued to aid industrial instrument users in defense and non-defense industries to gain maximum life and efficiency from pyrometric equipment now installed and being installed. It will be supplemented by similar informational bulletins, if required.

Defense bulletin No. 1 is designed to aid all users of pyrometers, regardless of make, to maintain equipment so it will operate efficiently and give uninterrupted service. It suggests substitute materials that may be em-

ployed in place of materials made critical because of the war program, and compares the properties of the original and substitute materials.

Copies may be had by addressing the company.

▲ A new, 16-page booklet describes use of Atlas Lumnite cement in making concrete which has full working strength in less than 24 hours of placing. Booklet also tells how to get fast results on concrete work in cold weather, using a minimum of protection. Detailed information is given on placing and finishing concrete floors ready for service the next day. Overnight concrete is especially useful for industrial maintenance jobs and for maintaining rush construction schedules.

▲ The Pyle-National Company announces the availability of their new floodlighting catalog No. 2100, which has just been re-issued.

This catalog illustrates and describes a complete line of floodlight projectors, from 10 and 12 inch short range types to the 36 inch heavy duty projector utilizing a 5000 watt lamp. A number of new portable types of floodlight projectors are shown.

This catalog gives complete specifications, including data on beam efficiency and candlepower, and light distribution with various types of lens equipment.

Floodlight equipment of the type shown in the catalog is being widely used for industrial plant protection at the present time.

▲ For use in electro-chemical, mining transportation, and steel mills, Ignitron rectifiers in the 250 to 900-volt range are described in a new 40-page bulletin announced by Westinghouse Electric and Manufacturing Company.

A complete technical discussion of design, construction, and operation covers the principles involved, rectifier circuits, and a description of the physical parts. Included in the construction details are vacuum-tight welded steel Ignitron tanks, anode and cathode assemblies, Ignitor, and cooling system. A number of diagrams, graphs, and photographs are used to make the discussion easy to follow.

Other features described include rectifier auxiliaries such as the hand-operated vacuum valve, mercury vapor vacuum pump, interstage reservoir, and power supply transformers. Interphase transformers, direct current voltage regulation and rectifier efficiency are also discussed.

Typical illustrations of installation in railway, mining, and general industrial use are described and illustrated.

Copies of booklet B-3024 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

▲ A new booklet telling how plant operators may get longer life and greater service from refractory linings is now available from the A. P. Green Fire Brick Company, Mexico, Missouri.

This folder on Greencote, a refractory maintenance coating for reconditioning furnace linings, is especially timely when all plant operators are faced with the problem of getting greater service from the furnace linings they already have.

TRADE AUTOMATIC MARK

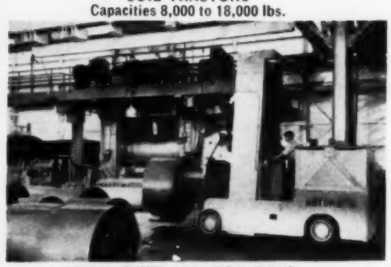
MANUFACTURERS FOR OVER THIRTY YEARS

MODERN *Electric Propelled* INDUSTRIAL TRUCKS

FOR ECONOMICAL MATERIALS HANDLING

- COIL AND FORK TRACTORS
- SHEET AND TIN PLATE HANDLERS
- BOSH TRUCKS
- LOW AND HIGH LIFT TRUCKS
- LOAD CARRIERS
- TRACTORS — CRANES

COIL TRACTORS
Capacities 8,000 to 18,000 lbs.



HEAVY DUTY COIL TRACTORS
Capacities up to 30,000 lbs.

FORK TRUCKS
Telescopic and Non-Telescopic Lifts
For Sheet Coils and Pallet Handling
Capacities 3,000 to 10,000 lbs.

HIGH LIFT TRUCKS
Tiering Platform Types

TIN PLATE HANDLERS
Non-Telescopic and Telescopic Lifts

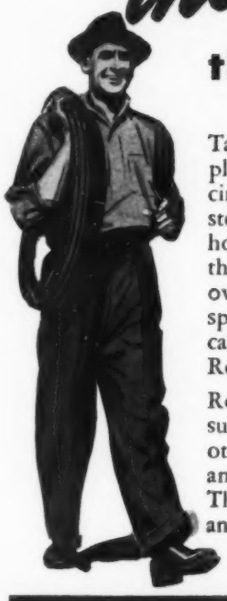
REQUEST DETAILS AND LITERATURE

Listed Under Reexamination Service of UNDERWRITERS' LABORATORIES

AUTOMATIC TRANSPORTATION CO.
47 W. 87th St. Div. of the Yale & Towne Mfg. Co. CHICAGO, ILL.

Mop up the Hot Spots

with wire that won't bake out



Take a trouble-shooting trip around your plant . . . check up on the power and lighting circuits that run around boilers, furnaces, steam lines, soaking pits, kilns, lehrs or other hot spots . . . and don't forget the motor leads that are taking more than their share of overload-heat, oil and grease. These are the spots where *trouble* starts—where wire and cable fail—spots where *permanently insulated* Rockbestos should be used.

Rockbestos wires, cables and cords are insulated to stand up in installations where other wires fail. They're not affected by heat and moisture, oil, grease or corrosive fumes. They can't burn. They mop up wire failures and prevent production interruptions.

Rockbestos A. V. C. Motor Lead Cable. Insulated with felted asbestos, heat-sealed varnished cambric and covered with an asbestos braid. Resistant to heat, flame, moisture, oil and grease. Sizes: No. 18 AWG to 1,000,000 CM. Underwriters' and Nat. Elec. Code Type AVA, max. operating temp. 110°C. (230°F.).

Rockbestos A. V. C. Power Cable. Laminated felted asbestos and varnished cambric insulation and a rugged asbestos braid withstands heat and condensation in boiler rooms, steam tunnels, etc. Sizes: No. 18 AWG to 1,000,000 CM. Underwriters' and Nat. Elec. Code Type AVA, max. operating temp. 110°C. (230°F.).

Rockbestos A. V. C. Boiler Room Wire. High dielectric varnished cambric, felted asbestos and a heat, flame and moisture resistant asbestos braid insures permanent performance in hot locations. Sizes: No. 18 to 4/0 AWG. Underwriters' and National Electrical Code Type AVA, max. operating temp. 110°C. (230°F.).

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Ohio State University
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Great Lakes Steel Corporation
Detroit, Michigan

ITEMS OF INTEREST

George L. Stout has been appointed district sales manager for the Colt's Patent Fire Arms Manufacturing Company covering the cities of Pittsburgh, Cincinnati, Cleveland, and Detroit. His headquarters effective May 1 will be in Cleveland, Ohio. Mr. Stout has been associated with the Colt's company for the past 16 years. Previous to that, he had also been with the National Carbon Company and the Martindale Electric Company. He has been an associate member of the Association of Iron and Steel Engineers for many years.

John J. Bangert has been appointed district sales manager of the Pittsburgh and Cincinnati districts of the Crouse-Hinds Company. Mr. Bangert began his career in the electrical department of the National Tube Company, McKeesport, Pennsylvania, transferring to his present affiliation in 1920. He has been a member of the Association of Iron and Steel Engineers since 1920.

Sam B. Heppenstall, Jr., formerly general sales manager, Heppenstall Company, Pittsburgh, has been promoted to vice president in charge of sales. Mr. Heppenstall joined the company 14 years ago as a laborer, was made assistant sales manager in 1933 and general sales manager in 1939. Mr. Heppenstall is an associate member of the Association.

A. H. Wardwell has been appointed director of industrial relations, Pittsburgh district, Carnegie-Illinois Steel Corporation. He was recently assistant to the general superintendent of the corporation's South Works, Chicago and previously had been assistant general superintendent at the McKeesport plant. For a number of years Mr. Wardwell was associated with the blast furnace department of National Tube Company.

SAM B. HEPPENSTALL, JR.

G. S. Mican has been named assistant to general superintendent, production planning of Carnegie-Illinois Steel Corporation's South Chicago works. Associated with South works since 1919, he was recently assistant division superintendent of rolling. E. W.

GEORGE L. STOUT

JOHN J. BANGERT

Pierce, recently superintendent of the production department, has been appointed assistant to general superintendent, quality control. **R. A. Ballinger** has been promoted from assistant superintendent of the production department to succeed Mr. Pierce.

Ernest E. Tross has resigned as general superintendent and works manager, United Engineering and Foundry Company, Youngstown, Ohio, to become a vice president, Federal Machine and Welder Company Warren, Ohio.

R. H. Cramer has been appointed factory manager, Hyatt Bearings division, General Motors Corporation, Harrison, New Jersey. Formerly assistant factory manager, Mr. Cramer succeeds C. P. Millard, resigned. Mr. Cramer joined Hyatt in 1922 as tool designer and successively served in the methods and equipment, standards and production departments.

John W. Sheffer, associated with American Car and Foundry Company since 1908, has recently been appointed general electrical engineer of that company.

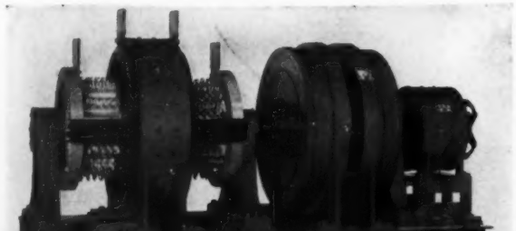
Mr. Sheffer graduated from Cornell University in 1907 with an M. E. degree and later in 1933 obtained his M. A. degree from Columbia University.

He began his association with a.c.f. in 1908 at the Berwick plant acting first as electrical engineer and later in the capacities of assistant to the general superintendent and plant engineer. During these 17 years he was engaged also with welding developments of all description, and was particularly responsible for the development of the Berwick electric rivet heater.

THE WAPAKONETA MACHINE CO.
Incorporated 1891 — Wapakoneta, Ohio.

Increase Production — Improve Quality

WITH THESE QUALITY-MADE COLUMBIA PRODUCTS



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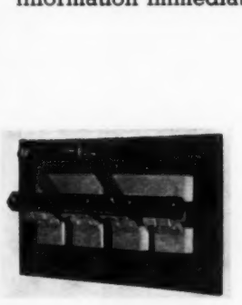
Columbia Reversing Switches are of the double pole, double throw type for use as reversing switches or series parallel switches on circuits up to 15 volts, 200 to 2,000 amperes.
Columbia Rheostat sizes range from 15 to 5,000 amperes and with a 3 to 6 volt drop.

In these days of speed, speed, speed, you'll want to know the facts about Columbia Low Voltage Generators, Plating Tank Rheostats and Reversing Switches. For more than 15 years these Columbia products have been meeting the production and quality demands of the plating industry and, of relatively equal importance, we have them available now for prompt shipment.

Write us your needs and we will send you complete information immediately.



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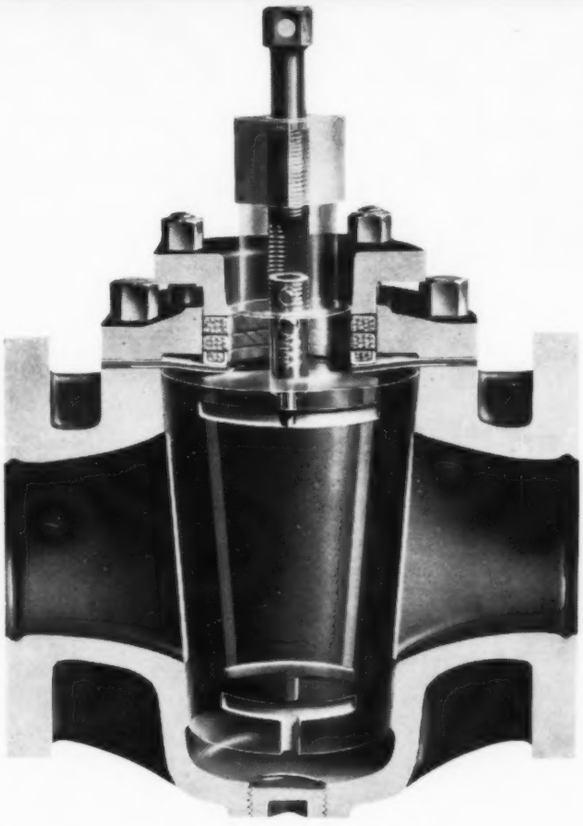
REVERSING SWITCHES



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Lubricated Valve
on your lines handling high pressures, corrosive acids, gases, etc.

The Nordstrom Lubricated Valve is more than a valve. It is a positive control that gives your lines instant shut-off, non-sticking action and freedom from the prevalent troubles of gate valves.

The plug is lubricated by hydraulic pressure. Stick lubricant is inserted under the top lubricant screw. By turning the screw, pressure is exerted through channels to the bottom of the plug. In case the plug ever becomes hard to turn you simply turn the lubricant screw and the plug is lifted slightly from its tapered seat.

For services requiring extremely high temperatures or where corrosive or erosive line contents are handled we can furnish Nordstrom Merchrome Coated Valves—hard faced. They will not gall. Merchrome Coating is especially desirable when Stainless Steel or special alloy valves are required.

Nordstrom Valves are available in sizes from ½" to 30". Working pressures to 5000 lbs. Temperatures to 1000° F.

These valves are especially desirable on gas fuel lines, acid lines, coking lines, light oil and benzol still residue lines.

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A Subsidiary of Pittsburgh Equitable Meter Co.
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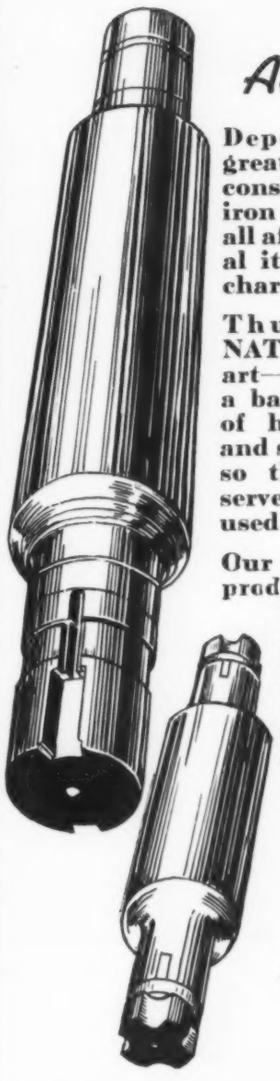

ROLLS
As a Fine Art

Dependable rolls are of great importance when one considers that steel and iron production itself, and all after-assemblies of metal items, depend on their character.

Thus the making of NATIONAL ROLLS is an art—a fine art—of creating a base of rigid resistance, of hardening, machining and smoothing the exterior so that the shapes may serve well wherever they are used.

Our instincts regard the production of NATIONAL ROLLS as not merely a business, but as a high achievement, with profit only as a reward and a means for continuance of the art.

H. H. Seaman
President and General Manager

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Rolls & Rolling Mill Equipment
AVONMORE, PA.

DUAL FUEL ?

Flexible Hagan Control operates with alternate fuel supplies, *without* manual readjustment

HAGAN CONTROL PANEL for soaking pits at Atlantic Steel Company, Atlanta, Ga. The flexibility of Hagan Control provides efficient, economical operation with either gas or oil.

IF you are planning a new system, or if today's unsettled conditions necessitate converting your present installation to accommodate a supplementary fuel, Hagan Control will provide fully automatic operation with either fuel supply, without further manual adjustment.

As an example, the original soaking pits in the Atlantic Steel Company plant were fired by manually controlled natural gas. When new pits with Hagan Automatic Combustion Control were installed in 1938, substantial reductions in fuel costs, increased tonnage and lower production costs through more uniform heating were achieved.

Recently these soaking pits were converted for oil firing, with provision for return to gas at a moment's notice. Simply shutting off one fuel supply and turning on the other is all that is necessary. The Hagan Control operates with either supply . . . and, by eliminating the necessity for manual compensation, does so with complete safety.

Whatever fuel you find most economical . . . whatever fuel you find most expedient . . . whether you are concerned with soaking pits, open hearths, or billet heating furnaces . . . Hagan Control offers you flexibility, increased efficiency and improved steel quality, with economy and safety. Tonnage increases of 5 to 10% and fuel savings as high as 20% are a matter of record. Bottom-making is reduced from once a day to once every week or so. In many cases the Hagan Control system pays for itself in a few months . . . then starts to earn dividends.

If uncertain fuel supply has raised a problem, or you have a combustion bottleneck in your plant, write or wire us now. We'll send a Hagan engineer to help you at once.

HAGAN CORPORATION • 300 ROSS STREET • PITTSBURGH, PA.

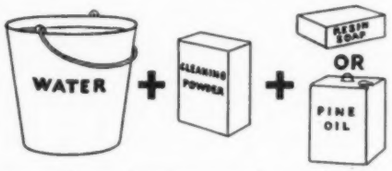
HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

How to increase the Life of your Oxy-Acetylene Welding and Cutting Hose . . .

Uninterrupted use of the oxy-acetylene process is vital to industrial maintenance and production. It is therefore reasonable to expect the continued manufacture of adequate amounts of oxygen and acetylene hose for use in the many essential applications of this process. However — as with any product made of materials subject to strict rationing — certain limitations on manufacture of hose, and restrictions on sale, are inevitable. It is therefore to the advantage of everyone to increase the useful life of all oxygen and acetylene hose in service.

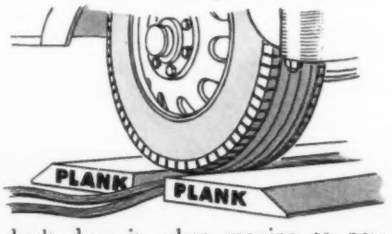
1. ***Protect hose from oil and grease,*** as these cause rapid deterioration of rubber. If oil or grease do get on hose, remove with water and any commonly used cleaning agent supplied in powder form, such as "Oakite;" or with con-



crete floor cleaning powder. Addition of about 5 per cent pine oil or resin soap will facilitate cleaning. Do not use gasoline, kerosene, or any cleaner containing caustic soda or potash.

2. ***Avoid burning of hose*** due to careless use of blowpipes, or from permitting hose to contact hot objects.

3. ***Avoid kinks*** and undue abrasion or abuse when handling hose. Coil it—



don't drag it—when moving to new locations. If hose crosses the path of vehicles, protect it by planks.

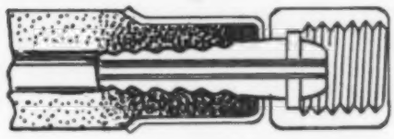
4. ***Use short lengths of hose.*** Short lengths not only are more readily available, but are more easily protected from

damage. By inserting couplings in the ends of hose as illustrated, several short lengths can quickly be joined when required.

5. ***Test hose regularly over its full length*** by immersing it in water while

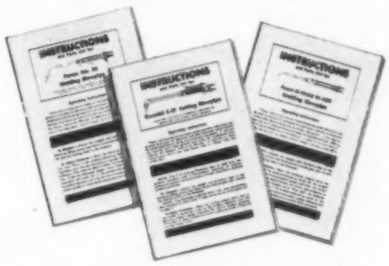
under operating pressure. Cut out leaky sections at once and rejoin the hose ends by using hose splices as shown above.

6. ***Test all hose connections for leaks*** by brushing on soapy water while the hose is under operating pressure. If leaks are found—or if hose ends are worn—cut the ends off back to sound



rubber and reassemble ferrules and nipples, as diagrammed above.

7. ***Operate blowpipes only at pressures recommended*** in the apparatus instruction book. Keep blowpipes in



good condition to avoid damaging flashbacks. Use oxygen and acetylene hose only for the purpose for which each is intended.

8. ***Purchase hose only when actually needed.*** Rubber deteriorates while on the shelf, with resultant shortening of useful life.

* * *

Send for Helpful Literature

The steps described here not only will conserve hose, but will conserve gas and contribute to the safe use of the oxy-acetylene process. Duplicate copies of the instruction booklets furnished with apparatus supplied by Linde are available without cost upon request. Also available is the helpful booklet, "Precautions and Safe Practices", which gives full instructions for setting up apparatus correctly. Write for the copies you need—today.

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(Push button control installation)

(A manually operated installation)

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EASILY INSTALLED, CENTRO-MATIC SYSTEM LUBRICATES *ALL* BEARINGS from a SINGLE SOURCE

...Permits machines to be run 7 days and 7 nights a week without taking time out for lubrication service

Speed up is the order of the day—and to keep production rolling at top speed, it is vitally important that all bearings on every machine be properly lubricated... And that's where Lincoln Centro-Matic Systems can do a job for YOU. They are easily installed on new or old machines, and systems are available for your particular needs.

A Centro-Matic System consists of a number of Centro-Matic Injectors—one for each bearing—and a suitable Centro-Matic lubricant pump. The injectors may be grouped in one location or located separately at each bearing. In either arrangement only a single lubricant supply line is required. The lubricant pump may be hand or power operated—Power operated systems may be semi-automatic or full automatic.

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—or send us specifications of the machinery to be lubricated, and our engineers will gladly make recommendations. No obligation.

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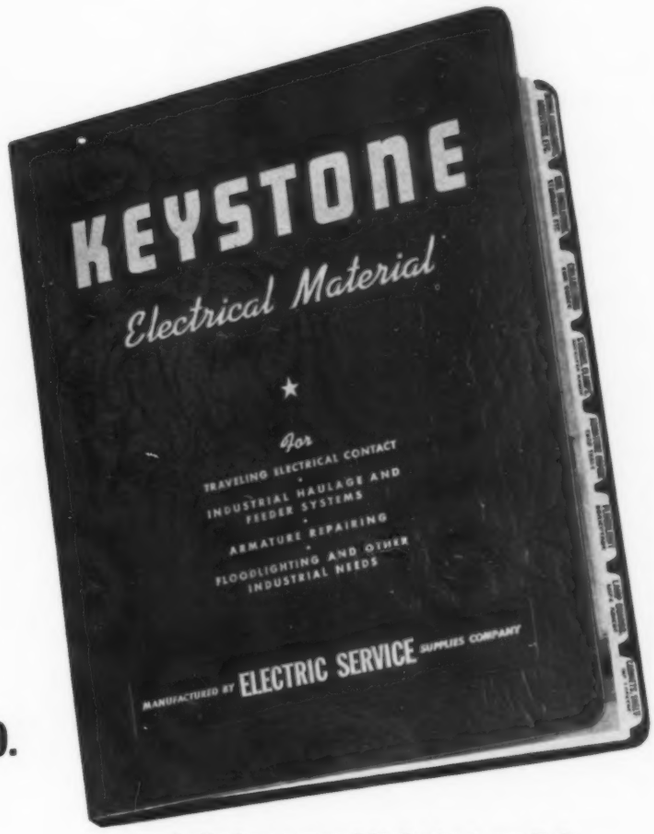
Type K, Keystone Faraday all-electric air-blast signal, produces non-synchronous trumpet blast, distinctive, penetrating. Output approx. 60 decibels at 300 feet. A.C. or D.C. length 24 inches.

Keystone-Faraday industrial bells, plunger-plug-in type, eliminates permanent magnets and hinged armature. Modern, efficient, can be installed on outlet box, quickly at little cost. A.C. or D.C.



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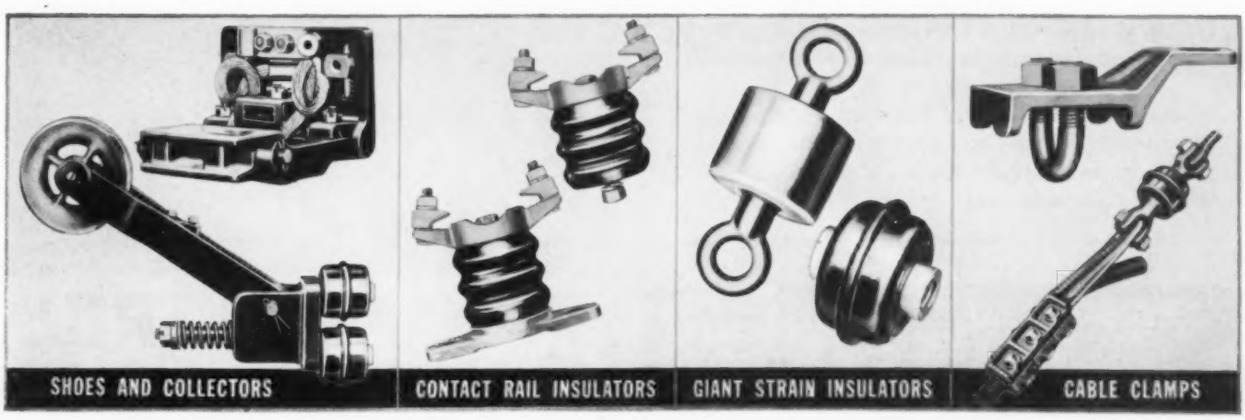

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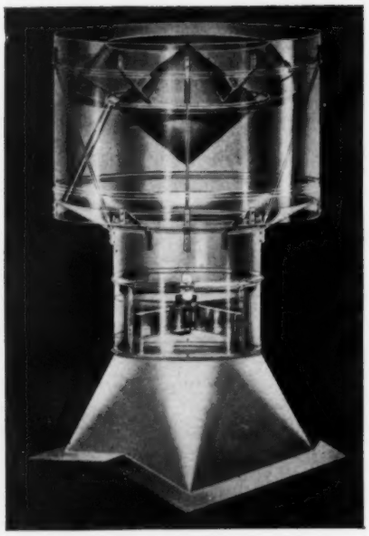

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Among Free-Flow Fan, Free-Flow Gravity and Monovent you will find a type of Burt ventilator to meet every requirement. Write for detailed data and job references.

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ROOF VENTILATORS • OIL FILTERS
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SEND FOR CATALOGS
Burt Engineers are glad to help on plans

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BY USERS EVERYWHERE

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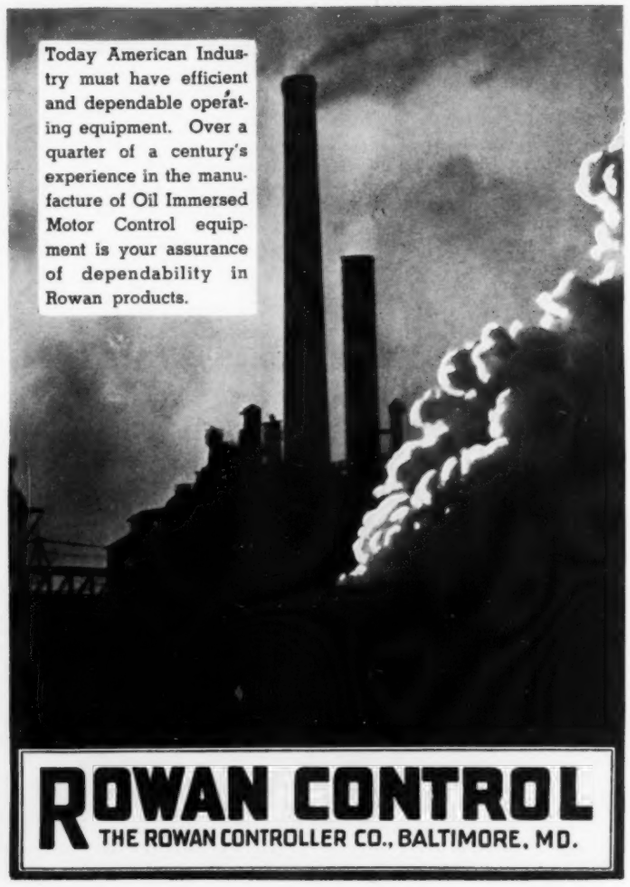
THE ROWAN CONTROLLER CO., BALTIMORE, MD.



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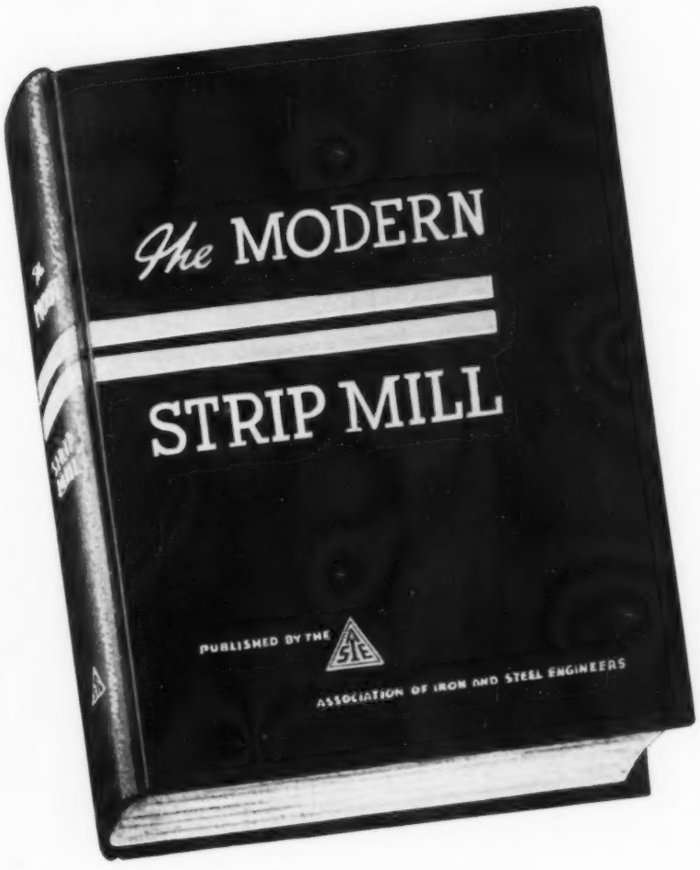
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

FOR STEEL PLANT ENGINEERS



The Modern Strip Mill, published by the Association of Iron and Steel Engineers, is a complete recording of the installations and practices of the 28 wide continuous strip mills in the United States. The book represents the first handbook presentation of any branch of the steel industry, and the information contained is available from no other single source.

Great care has been exercised in the preparation of this work so that information contained therein will be of permanent value. Strip mill practice, as followed in the wide strip mills in the United States, has been carefully described in the first part. In the second part, available data on all of the 28 individual installations have been tabulated in a thorough and complete manner. Contained within each section is detailed catalogue information that has been prepared by the suppliers of steel mill equipment and services.

The book has been distributed to A. I. S. E. members, and a limited number of copies are now available for sale to those interested. Concessions are offered to new members. For complete information, write A. I. S. E. headquarters.

"THE MODERN STRIP MILL"

PART I—Equipment and Process

SECTION I—GENERAL
Product—History—Installations—Capacity—Steel quality—Process—Selection of mill size.

SECTION II—SLAB HEATING
Slab yard—Slab heating furnaces—Depiler—Charging table—Pusher.

SECTION III—HOT STRIP MILL
Stand spacing—Roughing scalebreaker—Roughing stands—Turntables—Slab pusher—Slab squeezer—Edgers—Universal roughers—Crop shears—Finishing train—Mill speeds—Loopers—Screwdown—Roll balance—Guides—Drafting—Strip temperature—Rolling pressure—Hot mill operation—Disposal of product—Flying shears—Coilers—Mill tables—Descaling.

SECTION IV—MILL PARTS AND ACCESSORIES
Housings—Rolls—Roll changing—Cold mill roll grinding—Gear sets—Lubrication—Bearings.

SECTION V—ELECTRICAL EQUIPMENT
Rolling power calculations—Energy saving—Mill drives—Motor room design—Motor room ventilation—Power supply.

SECTION VI—PICKLING
Continuous pickling lines—Batch pickling.

SECTION VII—COLD MILLS
Tandem mills—Reversing mills—Reductions—Maintenance of gauge—Strip tension—Mill speed—Coolant—Rolling power calculations—Data from typical mills—Temper mills.

SECTION VIII—HEAT TREATING
Annealing—Normalizing.

SECTION IX—PROCESSING AND MATERIAL HANDLING
Shearing, etc.—Galvanizing—Electrolytic cleaning—Tinning—Cranes—Trucks—Conveyors.

PART II—Mill Descriptions

This part contains available data on each of the 28 wide strip mills installed in the United States. Complete tabulations and mill layouts are included.

THE ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING, PITTSBURGH, PA.

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MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

A Modern

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just dropping a good lift of steel at The Otis Steel Co. dock.

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The OHIO Electric Mfg. Company
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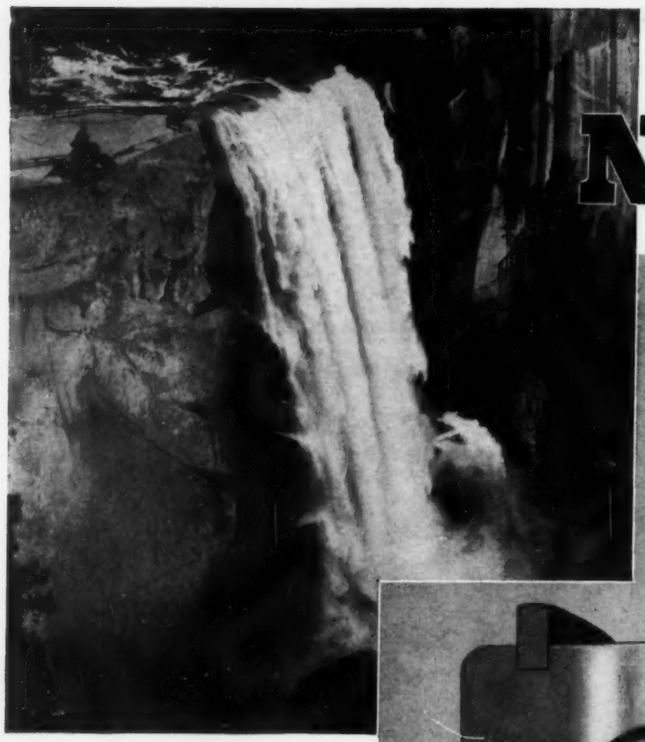
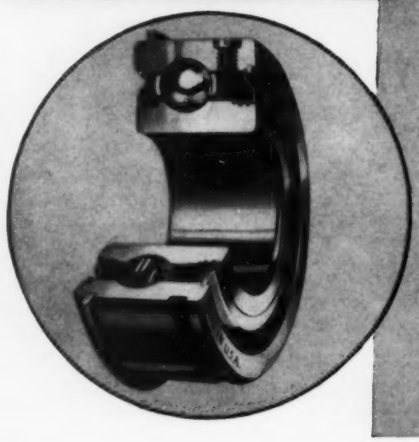
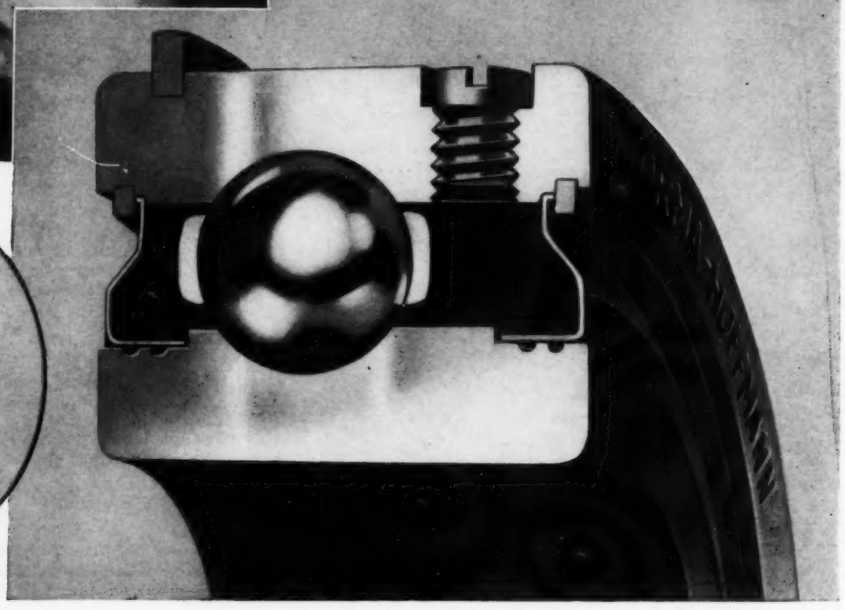


NO *Fear of* GOING DRY!





What water means to the earth, lubricant means to a bearing — life itself. And as the mountain stream provides an abundant and constant flow of water, so the exceedingly large grease capacity of the "CARTRIDGE" BALL BEARING provides constant and abundant lubrication to its raceways and rotating elements.

In the cross-section herewith, note how the DOUBLE-ROW WIDTH GIVES THE "CARTRIDGE" BEARING DOUBLE THE GREASE CAPACITY of the single-row type — guarding against premature dryness. Note also how the in-built metal seals confine the grease WITHIN THE BEARING ITSELF, REGARDLESS OF THE ANGLE OF THE SHAFT.

The "CARTRIDGE" BALL BEARING is equipped with close-fitting, wearless metal shields which, with recessed inner ring construction and two or more grease grooves, form a truly effective labyrinth through which THE GREASE CANNOT PASS AND DIRT CANNOT ENTER.

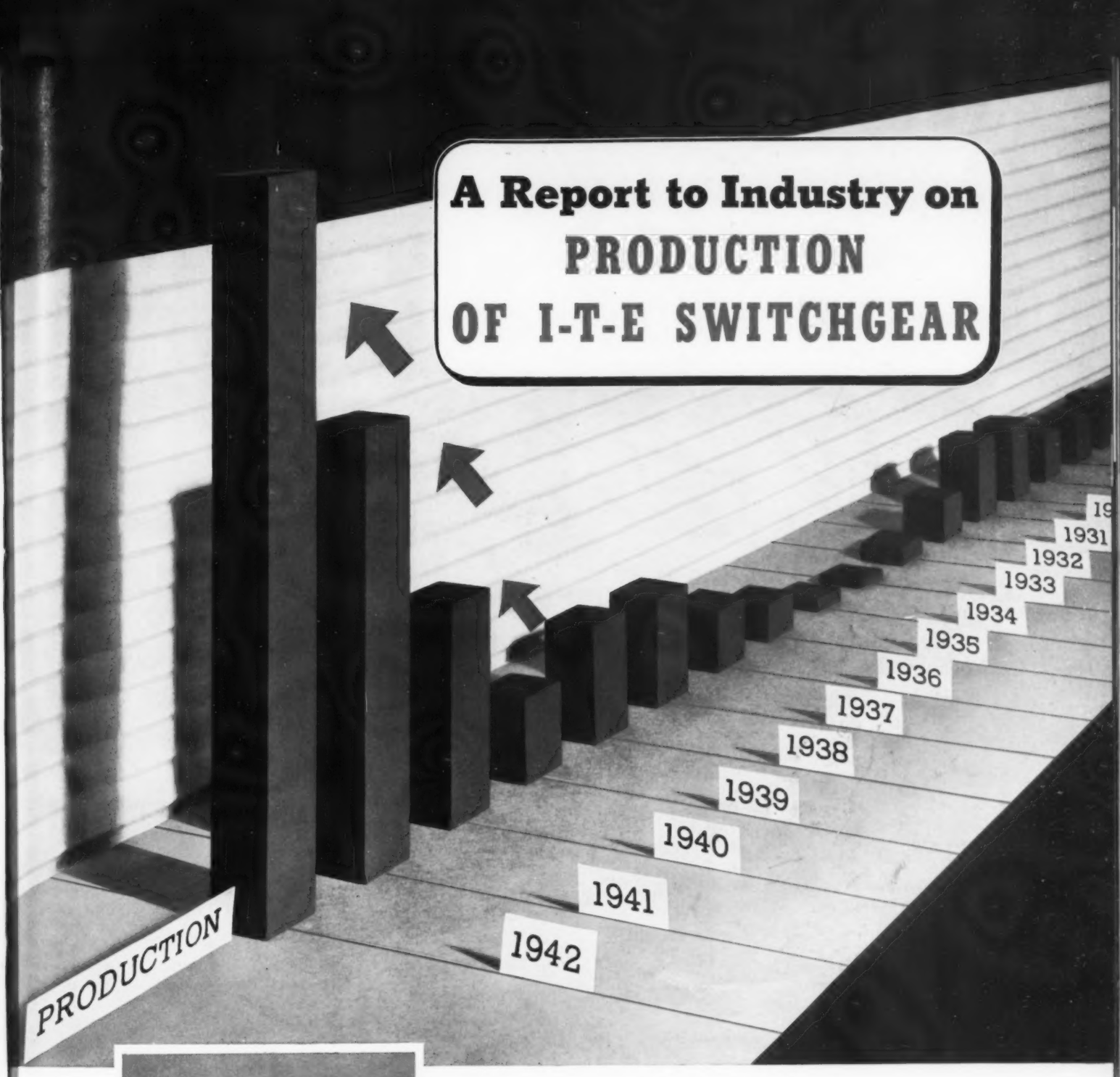
Adopt the "CARTRIDGE BALL BEARING as your insurance against neglected lubrication, and dirt and grease contamination. It is handled as an integrally sealed unit, needing no supplementary closure parts. It provides easier and quicker assembly and disassembly. It STAYS CLEAN before mounting, during assembly, or when removed, and has convenient regreasing and inspection features.

Write for the Catalog. Let our engineers work with you.

NORMA-HOFFMANN BEARINGS CORP'N., STAMFORD, CONN., U.S.A. • FOUNDED 1911

PRECISION BALL, ROLLER and THRUST BEARINGS

A Report to Industry on PRODUCTION OF I-T-E SWITCHGEAR



These blocks represent annual shipments, including a carefully-figured prediction for all of 1942.

Increase in production of switchgear is achieved by production efficiency but not by short-cuts. Each completed structure has to function perfectly. It has been a matter of acquiring new facilities and providing skilled hands.

The rise would have been far less steep had events not presented themselves in a way that encouraged I-T-E expansion well back in '38.

Look at the recent blocks in terms of necessary protection for ships at sea, for new or enlarged factories making war materials and for power plants serving war industries.

I-T-E

AIR SWITCHGEAR

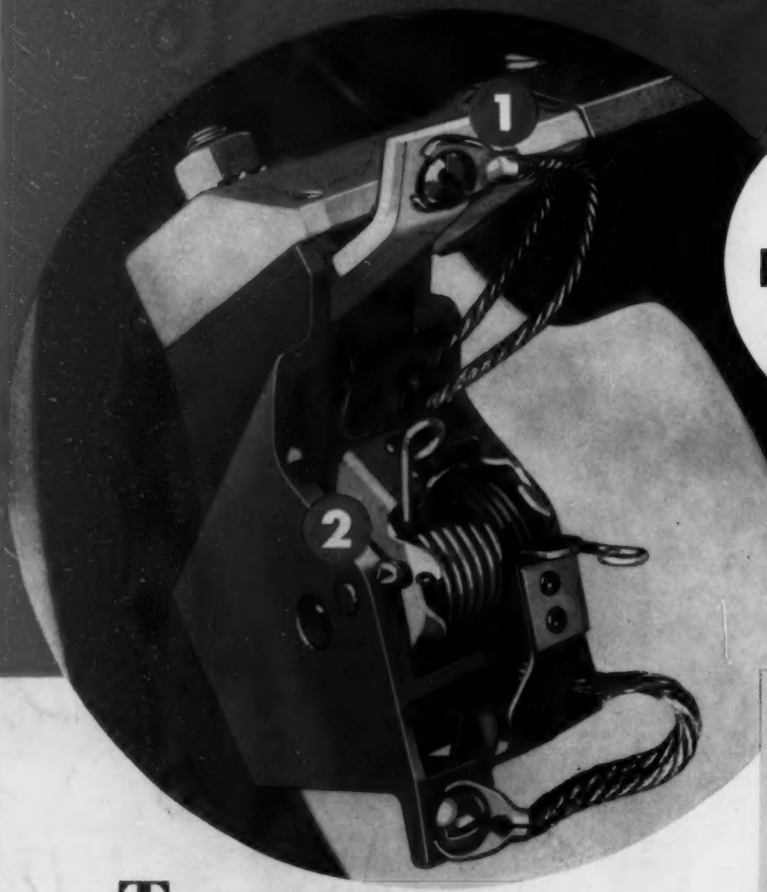
IMMERSED IN AIR • ENCASED IN STEEL

I-T-E

Representatives in Principal Cities

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

TAKE A LOOK At This Brush Rigging



It's ONE REASON Why Our New D-c Motors Are So Dependable, and So Economical

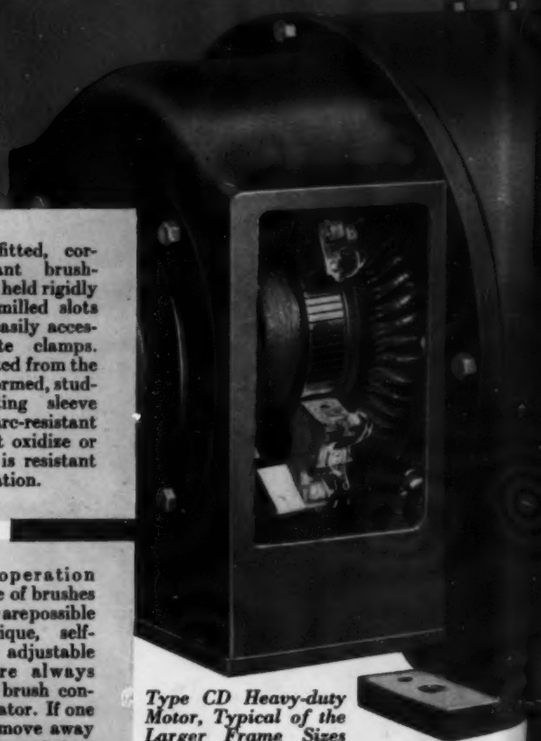
THIS improved brush rigging is but one of the many new features of General Electric direct-current motors. Stable operation is assured by the positive contact of the simple, compensating-action holder construction. Steady, economical performance of these motors year in and year out is possible largely because of the rigid, sturdy, and accurate assembly of this vital part.

Our attention to design detail, together with the use of the latest methods and materials—from the inside out—gives you d-c motors qualified better than ever to fill the needs of industry.

Competent engineers in the nearest G-E office will be glad to point out the many advantages you get from the new and improved features of this outstanding motor. Call them, or send for bulletin GEA-1868B. General Electric, Schenectady, N. Y.

1 Accurately fitted, corrosion-resistant brush-holder studs are held rigidly in position in milled slots by simple and easily accessible flat plate clamps. Studs are insulated from the yoke by a hot-formed, stud-shaped insulating sleeve that is highly arc-resistant—that does not oxidize or carbonize—and is resistant to any deterioration.

2 Smooth operation and long life of brushes and commutator are possible because a unique, self-compensating, adjustable spring pressure always maintains good brush contact on commutator. If one brush tends to move away from the commutator, additional pressure is exerted on its companion, thus assuring excellent commutation.



Type CD Heavy-duty Motor, Typical of the Larger Frame Sizes

GENERAL ELECTRIC